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SUICIDE AND MENTAL DISEASE

A CLINICAL ANALYSIS OF ONE HUNDRED CASES

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Suicide occurs in a great variety of settings, and to the psychiatrist who deals with personality disorders daily it is a serious practical problem. The generally accepted principle that all depressions are potentially suicidal is a simplification that has little value unless it is associated with a deeper analysis of the patient's life situation. The underlying factors are individual but, complex as these may be, it is reasonable to assume that some common determinants exist in such a universal phenomenon. Study of persons suffering from mental disease should help in this evaluation.

The present discussion consists of a general review of the clinical records of one hundred patients who have committed suicide. The group comprises sixty-one men and thirty-nine women. The study includes a diagnostic enumeration, a correlation of the intensity of the desire for suicide with the type of psychosis, some reference to the methods used and an analysis of the motives behind the act itself. A brief reference to family propensity is also made.

MATERIAL

The diagnostic groupings (table 1) are: manic-depressive psychoses, forty-six cases; involutional melancholia, nineteen cases; schizophrenia and paranoid conditions, fifteen cases; psychopathic personality, nine cases; dementia paralytica, five cases; psychoneuroses, four cases; encephalitis, one case, and epilepsy, one case. It is well known that suicide may occur in any type of mental disease, both organic and functional. In the present series there are eight diagnostic groups.

In keeping with the general observation that suicide is most common among patients with the manic-depressive psychoses, it will be noted that 46 per cent, or almost one half, of the cases of suicide discussed here are in this group. The organic psychoses are represented by five patients with dementia paralytica and one with encephalitis. Two of the patients with dementia paralytica were excited, with expansive trends; the other three were depressed and hypochondriac. The patient with encephalitis was also depressed, with many physical complaints.

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The four patients with psychoneuroses included in the series had severe neuroses. The diagnoses were based on the lifelong personality reactions of the patients, but the acute phase of the disorder, including morbid fears, depression and various hypochondriac symptoms, resembled a mixed manic-depressive reaction. As a group, so many neurotic patients think and talk about suicide that it is often necessary to consider them as potentially suicidal, but I am inclined to believe that suicide is rare in persons with psychoneuroses unless a depressive psychosis develops on such a background.

Seventy-six of the one hundred patients committed suicide after leaving a hospital in which they had been under treatment. Correlation of the diagnoses with the length of time the patients were out of the hospital before committing suicide provided interesting data as to the immediate or remote possibility of suicide in patients with the different psychoses. Table 2 gives a brief summary of these data.

TABLE 1.—*Diagnostic Grouping of One Hundred Cases of Suicide*

Diagnosis	Men	Women	Total
Manic-depressive psychoses	24	22	46
Involutional melancholia	11	8	19
Schizophrenia and paranoid conditions	8	7	15
Psychopathic personality	8	1	9
Dementia paralytica	5	0	5
Psychoneuroses	3	1	4
Encephalitis	1	0	1
Epilepsy	1	0	1
	61	39	100

TABLE 2.—*Length of Time Patient Was Out of Hospital Before Suicide Occurred*

Diagnosis	No. of Cases	Shortest Time	Longest Time	Average Time
Schizophrenia and paranoid conditions	15	2 days	12 mos.	2.0 mos.
Involutional melancholia	9	2 days	9 mos.	3.6 mos.
Psychopathic personality	9	3 mos.	96 mos.	52.8 mos.
Manic-depressive psychoses	36			
(a) Circular type	11	5 mos.	39 mos.	15.5 mos.
(b) Depressive type	10	3 days	5 mos.	2.8 mos.
(c) Mixed type	15	1 day	2 mos.	0.5 mos.

The data for two of the patients with organic disease are not included in table 2; one patient, who had encephalitis, was admitted twice to a hospital and committed suicide two weeks after his second discharge; another patient, who had dementia paralytica, killed himself a year after he left the hospital. Three patients with psychoneuroses died nine days, sixteen days and ten months, respectively, after leaving the hospital. The data for two other patients are not included, as they were incomplete.

The significance in the findings presented is not so much the average length of time that the patients were out of the hospital before suicide, for this applies only to the present cases; of greater importance is the striking difference in the time spent out of the hospital before suicide by patients with certain psychoses.

In the cases of schizophrenia all types were included except hebephrenia. Thirteen of the patients had made one or more, usually several, serious attempts to end

their lives before they finally succeeded in doing so. Only two seemed influenced by hallucinatory demands. It will be noted that the average span of life for this group after discharge from the hospital was two months. All the patients had been discharged, some going to other hospitals; one patient had eloped two days before he killed himself.

There were nine patients with involutional melancholia who spent an average period outside the hospital of three and six-tenths months before committing suicide. One might expect that this group would be greater numerically and more acutely suicidal than the group with schizophrenia. Perhaps this is not so because of the common observation that until improvement begins in the involutional psychoses the symptoms are severe enough to convince the most insistent relative who seeks the patient's discharge that the responsibility is too great. Furthermore, once convalescence has begun it usually continues without danger of relapse, and recovery may be rapid, even though the acute symptoms have existed for many months.

A striking difference is noted when one compares the two foregoing groups with the group of nine patients with psychopathic personality. One of these patients, a drug addict, drowned himself three months after leaving the hospital; a second died in eight months, but the others lived from two to eight years after discharge, the average period of time being fifty-two and eight-tenths months (the average period for the patients with schizophrenia being two months and that for the patients with involutional melancholia, three and six-tenths months). This long interval is in keeping with a proper evaluation of the psychopathic personality, as frequently the suicidal attempt is weak, efforts are half-hearted, and actual death, more often than not, is an accident in a dramatic setting.

In the final group, that of the patients with manic-depressive reactions, it is necessary to divide the thirty-six patients who committed suicide after leaving the hospital into three clinical types. The extreme difference in time between the three groups before suicide occurred may then be noted. First, there are those with circular reactions. These are the patients who have shown alternating phases of manic and depressive behavior, separated by transitional periods of short duration during which they appear to be well. The alternating moods may be intense at times, but for many months the patient may live outside a hospital in a hypomanic state which, to the casual observer, suggests unusually good health. When the pendulum swings the other way, the depression, on the surface, seems so slight that it is easily overlooked. However, if the patient has previously shown definite self-destructive tendencies, the danger of suicide in opportune circumstances is great. These patients often leave the hospital in a comfortable condition, and unless adequate attention has been given to the longitudinal picture of the illness, the temporary nature of the improved state will not receive sufficient emphasis, with tragic consequences.

Eleven of my patients (table 2) were in the group with circular reactions, and the span of life after discharge from the hospital extended from five months in one case to three years and three months in another. The average time for the group was fifteen and five-tenths months (one and three-tenths years). Several of the patients had two or more alternations in mood before the final depression appeared.

In the second group (ten patients) a depressive psychosis only occurred. Here there is a marked difference in the time after the patient left the hospital before suicide occurred. The shortest period was three days; the longest was five months and the average was two and eight-tenths months (the average for patients

with circular reactions being fifteen and five-tenths months). In a hospital the retarded depressions are not particularly dangerous so far as suicide is concerned, if the patients are kept occupied and under moderate supervision. It is only when the depression is lifting, often some weeks before the morbid and self-accusatory ideas have disappeared, that the possibility of suicide is less remote. Unfortunately, at this time a tendency to project the inner distress on the environment leads to complaints and pleadings, so that relatives, noting the improvement, agree with the patient that the hospital restrictions are prolonging the illness. The patient is then removed at a time when he is potentially more suicidal than at any time before.

Finally there are the patients with mixed manic-depressive states. The majority of these show the usual depression, numerous self-accusations, ideas of guilt and punishment and a varying degree of hypochondriasis. At the same time there is a mental alertness, associated with tense, apprehensive and restless behavior. The retardation of thought and action that paralyzes the acting out of the wish for death in the average depressed patient is entirely absent in these persons. They are, therefore, the most dangerous type of patients with mental disease, so far as suicide is concerned. The records of the fifteen patients in the group emphasize this strikingly. Three of these patients committed suicide twenty-four hours after leaving the hospital, two within forty-eight hours, another within a week and still another within two weeks. The patient who was longest outside the hospital lived two months, and the average period for this group was fifteen days! (the average period for the patients with circular psychoses being fifteen and five-tenths months and that for the patients with depressive psychoses, two and eight-tenths months).

To summarize this aspect of the study, it seems reasonable to state that an analysis of the length of time that these sixty-nine patients survived suicidal drives after leaving the hospital shows that certain types of patients are more prone than others to succeed in gaining the end desired by all. A careful study of the clinical picture should help in evaluating this.

There are other important criteria of value in estimating a patient's propensity to suicide, but these have been discussed in a previous communication.[1]

METHODS OF SUICIDE

It has been said that the method used to commit suicide has some significance in relation to the personality of the patient; furthermore, if evaluated properly, it represents psychologically the appropriate end-reaction of a psychic conflict. This is probably so, but suggestion and the availability of means are also important.

In the present series of cases the exact method used to commit suicide is known in ninety-four of the one hundred cases. In analyzing these data it is possible to construct two major divisions: (1) methods

1. Jameison, G. R., and Wall, James H.: Some Psychiatric Aspects of Suicide, Psychiatric Quart. **7**:211 (April) 1933.

which might be designated as active or aggressive and (2) methods which might be considered as passive or receptive. The details of these divisions are noted in table 3.

Contrary to the common belief that women use passive methods generally, it was found that twenty-three of the thirty-six women patients (approximately 64 per cent of the cases in which the method is known) used active means to die. Thirty-seven of fifty-eight men patients used active methods, in practically the same proportion of cases as the women (63.8 per cent).

Sixty-seven of the one hundred patients in the series had previously made one or more serious attempts at suicide, with more or less tem-

TABLE 3.—*Methods of Suicide*

	Number of Men	Number of Women	Total
A Active or Aggressive			
Shooting	10	0	10
Cutting	3	1	4
Hanging and strangulation	16	13	29
Jumping or mutilating actions	7	8	15
Burning and electrocution	1	1	2
Total	37	23	60
B Passive or Receptive			
Poisons	17	9	26
Drugs			
Deadly types	5	6	
Sedative types	1	2	
Gas			
Automobile	5		
Domestic	6	1	
Drowning	4	4	8
Total	21	13	34

porary injury to themselves. It is an interesting observation that of these sixty-seven patients, thirty-five, or over 52 per cent, followed their original tendencies, that is, their tendencies to use an active or a passive means to the end. One patient lacerated his scalp by diving from a porch; a second time he tried to dive from a train, and in his final attempt he threw himself headlong down a stairway, breaking his neck.

A woman patient took a sedative drug, with resulting long periods of unconsciousness, on two occasions before she committed suicide with the same drug in her third attempt. Numerous patients tried strangulation or hanging before they were successful by the same method. Another woman patient, who believed that she must be hanged as a criminal, was found in the cellar of her home with one end of a rope attached to a heavy weight which supported the other end swung over

a beam. Later, in a hospital she was found suspended by a carefully prepared hangman's noose, with a weight attached to one end of it, simulating an official execution, which she had tried to produce in her earlier attempt. Several patients who cut themselves unsuccessfully in previous attempts succeeded finally by the same method. So, in a general way, one could recognize in many of the patients a certain pattern or groove which was followed with few deviations in the individual patient's struggle for self-destruction.

MOTIVES FOR SUICIDE

The classification of patients and the presentation of statistics showing the tendency to suicide in various types of mental disease is of considerable importance from many practical angles, but it does not give any better idea as to why death is so often desired. Irrespective of the type of illness, it seems apparent, as insight into psychologic mechanisms becomes clearer, that every suicide has a more or less significant motive. The discussion of methods may have indicated this already.

The mentally sick patient often presents through his symptoms significant material which, if interpreted properly, leads to an understanding of the organization of the patient's personality. It is not because he has a psychosis per se that he is suicidal, assaultive or homicidal. The psychosis represents only a failure in his social or group adaptation, a temporary or partial paralysis of what might be called his acquired ability to inhibit, among other things, the expression of wishes or desires which run contrary to social custom. The child who, when frustrated, suddenly blurts out: "I'll kill you!" or, again, "I wish you would die. I hate you!" means this at the moment, but by the time he has reached an age when he is able to act out these thoughts and desires, inhibition has already modified his personal inclinations to do so. When one recalls that, primarily, the child is a narcissistic organism and that his love and hate tendencies revolve around this psychologic state, it must be evident that he has to suppress and sublimate a number of asocial strivings related to those about him. Only as he does so satisfactorily is his evolution toward an accepted social being successful. To understand the psychoses or, more particularly, the mental productions and the behavior of the patients, it must be recognized that the earlier repressed, inhibited or sublimated infantile and early adolescent "acting out" (asocial) tendencies have more or less free rein when the patient is ill.

The ingrained nature of the person is also of considerable importance in the type of symptoms. Some persons seem to enter the world with an inherent tendency to passivity; other children show early in life an aggressiveness that is readily apparent to their playmates. These

inherent dispositions may be covered over during the period of growth, for various reasons, so that the adult may show little of his earlier disposition until he becomes mentally sick. Often the unconscious traits are opposite to the conscious adaptations. A passive, agreeable or ingratiatingly meek personality in adult life may often cover a strong underlying sadistic aggressiveness, repressed in childhood but never destroyed.

Many suicidal patients, particularly the depressed, express a fear of losing their minds, a fear of insanity. This, in turn, is often associated with the fear of losing control of themselves, of not being responsible for their actions. Often the associations following this have been the fear of harming some one, of actually killing some one! The roots of such a fear go back to childhood. The child's threat, "I'll kill you" or "I wish you were dead," does not connote murder in the adult sense but merely expresses the wish for the elimination of the frustrating object. It is only later, as the child grows older and acquires the broadening concepts of personal and group responsibilities, that such expressions mean something more serious, but so long as repression is adequate the personality is not endangered. However, if the adult is subjected to an event or an emotion that tends to awaken the quiescent infantile part of his personality make-up, a struggle begins between the unconscious striving for gratification which seeks admission to consciousness and the repressing mechanism which tries to prevent it. The childhood wish to kill (to eliminate the offending object) is now treated by the adult personality in its struggle with reality relationships as though it actually existed in all its terrible significance. The symptoms of the psychosis, including, for instance, the fear or belief that one is going to the electric chair, that one is to be tortured or killed, that one has brought ruin to his loved ones or that one is a degenerate, all represent a compromise between the two opposing forces. That material of this nature comes from the unconscious infantile part of the personality is borne out many times by the feeling of omnipotence accompanying it. In early life the child is supreme, a complete narcissist. In the psychoses, particularly the depressions, one hears evidence of this omnipotence expressed over and over again. No one ever had such suffering or anguish; the death of the patient means death to all; he is to live forever, and the world must die; only he is tortured, and others live only to see him suffer; the world has never had such a criminal or one with such a disease.

This is only a small part of the story, but, suffice it to say, interpretation of the motives for suicide on the basis of infantile organizations, seems to give meaning to what otherwise appears futile and

senseless. In the one hundred patients studied material was available to classify motives, in a psychologic sense, somewhat as follows:

A. Major Themes

1. To destroy (or kill) in oneself an asocial primitive tendency which, if expressed in consciousness, would represent murder.
2. To destroy (or kill) in oneself the object of one's hatred which, through earlier identification and introjection, has become a part of the individual. This object is essentially one for whom the individual originally had positive rather than negative feelings.
3. To destroy incestuous strivings, in which the tendency itself, in being destroyed, carries with it the destruction of the total personality.
4. To destroy homosexual strivings which, like tendencies to incest, in being destroyed, result in the destruction of the total personality.

B. Minor Themes

1. Expiation or atonement, usually related closely to unconscious impulses toward murder, the personality responding to these impulses as though a crime had actually been committed.
2. Punishment motives, often related to incest, homosexuality, or masturbatory conflicts.
3. To obtain reunion in death with one whom reality has taken away.
4. Exhibitionistic motives, which often lead to half-hearted attempts, death being an accident rather than the result of a frank wish fulfilment.

A detailed discussion of these motives is not attempted at this time, but the major themes are so called because they occur often in this particular group. The minor themes, although important so far as actual suicide is concerned, were not as prominent in the one hundred cases as perhaps would be evident in a larger group of patients. As a general rule, the patients whose motives for suicide were based on wishes for murder, incestuous strivings and homosexuality used an aggressive or active method in their self-destructive actions. On the other hand, those in whom atonement, desire for reunion in death and exhibitionistic motives seemed prominent used more passive methods. To the student of personality the significance of these two different methods, psychologically determined by the underlying unconscious motives, is shown clearly in the patients' reactions to their previous failure to commit suicide. For instance, it has been noted that certain patients, on regaining consciousness after a suicidal attempt (strangulation), have suddenly become extremely violent, assaultive and even homicidal. Such a reaction may continue for several hours or even for a day or so, followed occasionally by an amnesia for this excitable period. These are the patients who show strong aggressive tendencies, and their murderous impulses are recognized easily during the height of the assaultive behavior. The failure to commit suicide does not resolve

the underlying conflict, but the compromise, as represented by the desire for self-inflicted death, is temporarily disrupted, so that the uninhibited, primitive fury is turned outward. The psychotic patient who impulsively attacks others over a period of time and then without warning kills himself probably follows a similar pattern in reverse order.

In contrast to this there is the common observation that certain patients after failure to commit suicide abruptly become much better mentally. The depression seems to lift; they are cheerful and agreeable, and temporarily (occasionally permanently) all the various fears and tension disappear. They are the patients who have resolved, partially or completely, the unconscious desire for punishment or atonement. This type of patient often expresses his suicidal drive by one or another of the passive methods already mentioned.

It is necessary to state, however, that the problem is not always as simple as my present remarks indicate. Persons usually have a mixture of aggressive or passive tendencies, and more than one psychologic conflict exists behind the suicidal drive. As a result, a combination of methods and motives is often recognized.

FAMILY HISTORY

In discussing methods and motives it was pointed out that the psychosis itself did not represent the actual cause of the drive for suicide. Considered otherwise, it represented a failure on the part of the personality to handle conflicts between the conscious social adaptation and the unconscious asocial strivings. Why some persons manage these problems successfully while psychoses develop in others is not definitely known. However, if one looks into the family histories of these patients, certain data are available which seem to indicate predisposition. Of the one hundred patients in the present series, sixty-one had one or more persons with psychoses or one or more suicides in the first or second generations of their families. This positive history of the families of sixty-one patients grouped together gave a total of one hundred and twenty-seven psychoses and thirty-two suicides. The full significance of this is open to conjecture, but it seems reasonable to state that such findings suggest an important diathesis.

SUMMARY AND CONCLUSIONS

Generally speaking, it is probable that many persons who commit suicide today are suffering from personality disorders. If a patient has been in a hospital for patients with mental disease his life history is well known, and if he commits suicide it is easy to see that the act is in response to a complex of factors which, classified clinically, represent a mental illness. However, it is often difficult for the physician to

convince the responsible relatives of this point of view before or even after the patient is admitted to a hospital. The potentially suicidal patient may be normal in an intellectual sense, with clear sensorium and good memory, so that, to the family, rationalization for a low-spirited condition seems natural. Then, too, one has also to deal with ingrained misbeliefs, fears and resentments associated with anything that might connote "insanity." If society could be brought to realize that a mental disease may be borderline, mild or even severe without reference to "insanity," many tragic results could be avoided.

In my group of one hundred patients, forty-six had a manic-depressive psychosis, which is ordinarily considered a recoverable illness. The patient with circular reactions and those with psychopathic personality had the longest span of life (one and three-tenths years and three and nine-tenths years, respectively) after discharge from the hospital; the patients with mixed manic-depressive psychoses had the shortest (fifteen days). There are several factors to account for this.

The majority of the patients showed a propensity for suicide throughout the illness, and a personality tendency to passive or aggressive action was present consistently not only in their talk and behavior but also in the methods used to commit suicide.

Irrespective of the mental illness, which may act as a releasing agent for the expression of the underlying conflicts, the motives for the suicidal drive come from infantile levels. It is only by recognizing this that the significance of the patient's trend and actions can be evaluated properly. On the basis of this approach a series of motives have been elicited.

Finally, the family backgrounds of the patients were reviewed. The material obtained indicates that a predisposition to return to psychologic levels of immaturity exists in certain persons. The assumption that this is so does not detract in any way from the therapeutic approach. As a matter of fact, it should intensify efforts to study and evaluate the earlier reactions of the patients. The recognition of infantile and preadolescent tendencies in the formation of the personality should be borne in mind particularly. It will then become evident that the developing child needs important consideration. The instinctive drives and objective relationships of this period need to be managed with tolerance and understanding. Forcing the child to repress his aggressive tendencies and emotional strivings by threats, fear and rigid attitudes of intolerance leads to a distortion of his otherwise natural repressive functions. On the other hand, a wise and sympathetic understanding should lead to the healthy sublimations and general feelings of security so necessary in the present social organization. If such a background is created, the adult who turns backward to earlier life situations when

he becomes mentally ill will have repercussions less severe than those so often irrevocably banished by death.

DISCUSSION

Dr. Mortimer W. Raynor: The study of suicide which Dr. Jameison has presented grew out of a practical and definite problem at Bloomingdale Hospital. From that study certain trends have been noted which we think can be applied in cases in which the patients do not reach the hospital. Of the one hundred patients, twenty-four committed suicide in various hospitals, and the remaining seventy-six, in the community. Some of these patients were regarded by relatives as well or practically well or were spoken of as having "a nervous breakdown" and were in no way considered by the family as being psychotic. Many persons attempt suicide in the community and are never studied. Many of the persons who commit suicide have been seen by physicians who have failed to grasp the significance of the situation.

It is significant that forty-six of the one hundred patients had manic-depressive psychoses; they were, for the most part, the restless, anxious type, many of whom until they actually made an attempt on their lives were considered as simply worried or nervous. I think that the diagnosis is tremendously important in understanding these cases. Dr. Jameison has pointed out that psychoneurotic persons are not so prone to harm themselves. Many of our cases were looked on at first as cases of psychoneuroses because of the anxiety, but on further observation and study the condition was finally diagnosed manic-depressive reactions of mixed types. I think that physicians and the members of the families in which there are persons with mental disorder should be sensitized to the problem of suicide. Every one is prone to grasp apparently obvious or superficial reasons as the cause for suicide, for instance, cancer. One thinks that it is reasonable that a person with an inoperable cancer may commit suicide. But of the considerable number of persons who die of cancer, only a few try to terminate their lives; so there must be some additional factors operating. The same can be said of almost every other situation, i. e., that there are other causes than the apparent superficial causes for suicide. There are persons with business reverses who attempt suicide, but think of the tremendous number of people who have had business reverses in the last five or six years who have not made any attempt on their lives. Our studies indicate that there are always some other causes.

One must also realize that once a patient makes an attempt at suicide he is almost sure to repeat it, probably by using the same method. Apparent sudden improvement in patients, as Dr. Jameison has pointed out, presents opportunities for successful attempts at suicide. In cases of retarded states there is less danger. In cases of anxious, agitated states in which patients have difficulty in making up their minds sudden changes in mood should be regarded with suspicion, as the patient may have completed in his mind a plan to end his life. This temporarily results in an improved mental state, as his problems seem settled. The indecision, anxiety and agitation having disappeared, he awaits only the opportunity. The relatives believe the patient is better than he really is; even the physicians relax their vigilance; the nurses are off guard and sometimes are taken off the case. One of the most difficult things, I believe, is to "sell security" in cases in which there are suicidal tendencies. Persons think that they know better than the physician in nine cases out of ten and rely on their own judgment because of the good showing that the patient makes.

Dr. Jameison has pointed out that the methods of suicide are important as showing certain trends in personality. I think that it behooves all physicians to make attempts to analyze personalities and forestall, if possible, self-destruction. Then too, if there is a history of other suicides in the family one must keep this fact in mind and not dismiss it lightly. Identification with some other member of the family is a common mental mechanism. If identification takes place with a member who ended his life one must certainly be on guard. It is a definite danger signal.

If one can prevent suicide, most of these patients will recover and resume their former places in the community.

OXYGEN SATURATION OF BLOOD DRAINING THE BRAIN AND THE LIMBS OF PATIENTS WITH EPILEPSY

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We have been trying to determine what part, if any, cerebral anemia or anoxemia plays in relation to the seizures of epilepsy. Previous articles have dealt with the cerebral blood flow before and during epileptic seizures,[1] with the effect on seizures of alteration of the oxygen tension of respired air,[2] with the degree of anoxemia required to produce unconsciousness [3] and with the oxygen saturation of arterial blood in epilepsy.[4] The last-mentioned study indicated a mild degree of anoxemia in about half the patients examined. In the present paper we report observations of the oxygen saturation of venous blood drawn from an internal jugular vein, a basilic vein and a femoral vein.

Apparently, except for a preliminary report by one of us,[5] an investigation of this nature has not been reported in medical literature.

MATERIALS AND METHODS

The patients examined were private patients or attendants at the Neurologic Clinic of the Boston City Hospital. There were both men and women but very few children. Preliminary to the taking of the blood, the patients lay quietly

From the Neurological Unit, Boston City Hospital, and the Department of Neurology, Harvard University Medical School. This paper is no. XVIII in a series entitled "Studies in Epilepsy." Aid in this research was received from the Harvard Epilepsy Commission.

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3. Lennox, W. G.; Gibbs, F. A., and Gibbs, E. L.: Relationship of Unconsciousness to Cerebral Blood Flow and to Anoxemia, Arch. Neurol. & Psychiat. **34**:1001 (Nov.) 1935.

4. Lennox, W. G., and Gibbs, E. L.: Oxygen Saturation of the Arterial Blood in Epilepsy, Arch. Neurol. & Psychiat., to be published.

5. Lennox, W. G.: Certain Chemical and Physiological Conditions Which May Influence Seizures, A. Research Nerv. & Ment. Dis., Proc. **7**:475, 1931.

for ten minutes or longer. In order to avoid emotional disturbances of circulation, venous punctures were made painless by the preliminary injection of procaine hydrochloride into the cutaneous area over the vein. If stasis was required for entering a vein in the arm, blood was not drawn till the normal circulation had been resumed. With the patient in a comfortable, horizontal position, the internal jugular vein was entered as it emerged from the skull.[6] The blood was drawn under oil and chilled, and measurement of the blood gases, by means of the Van Slyke[7] method and apparatus, was begun at once. The oxygen and carbon dioxide content of the blood and its oxygen capacity were measured. The oxygen content divided by the capacity gives the percentage of saturation with oxygen.

BLOOD FROM THE INTERNAL JUGULAR VEIN

The most important blood in the body for the purpose of this study is that within the internal jugular veins or their tributaries, for the oxygen tension of the blood leaving the brain most nearly approximates

Gaseous Content of Venous Blood From the Brain, Arm, and Leg in Groups of Patients with Epilepsy and with Various Neurologic Conditions

	No. of Determinations	Oxygen Content, Volumes per Cent	Oxygen Capacity, Volumes per Cent	Oxygen, Percentage of Saturation	Carbon Dioxide Content, Volumes per Cent
Internal Jugular Vein					
Epileptic	130	12.1	19.2	62.8	54.9
Neurologic	39	11.9	20.0	59.4	53.9
Arm Vein					
Epileptic	100	13.1	20.4	64.5	53.3
Neurologic	24	12.6	19.9	62.5	50.9
Normal	79	14.9	20.6	72.3	51.7
Femoral Vein					
Epileptic	50	12.9	18.8	68.5	52.4
Neurologic	14	14.8	20.6	71.8	53.1

the tension in the brain itself. Blood reaching the brain by the arteries may be normally saturated with oxygen, but if circulation in the small vessels is impeded, the brain will suffer from anoxemia. The impediment, if generalized, will reveal itself by abnormal reduction of the amount of oxygen in the blood in the veins.

Because of the importance of this point, a large number of observations were made, one hundred and thirty on one hundred and ten different patients. The average oxygen saturation of the blood of this large group was 62.8 per cent (table). We were excited by this finding at first, for we knew that the oxygen saturation of venous blood from the arm is in most instances between 60 and 80 per cent, with an average

6. Myerson, A.; Halloran, R. D., and Hirsch, H. L.: Technic for Obtaining Blood from Internal Juglar Vein and Internal Carotid Artery, Arch. Neurol. & Psychiat. **17**:807 (June) 1927.

7. Van Slyke, D. D.: Notes on a Portable Form of the Manometric Gas Apparatus and on Certain Points in the Technique of Its Use, J. Biol. Chem. **73**:121, 1927.

of about 72 per cent. In order for the brain to have a rich supply of oxygen, it might be expected that cerebral venous blood would have a higher oxygen saturation than blood from the less essential tissues of the arm. To find the oxygen saturation of blood from the internal jugular vein 10 per cent lower seemed a finding of real importance.

However, by measuring the oxygen saturation of the blood of patients with other neurologic conditions or with conditions which did not involve the central nervous system, as well as of some who were essentially normal, we arrived at the conclusion that a relatively low and constant oxygen saturation of blood leaving the brain was not a peculiarity of epilepsy, or indeed of neurologic conditions, but was probably normal. In thirty-nine measurements made on the blood of nonepileptic patients, the average oxygen saturation was 59.4 per cent, a figure slightly lower than the average for the epileptic group. The relatively narrow range of distribution of values for oxygen saturation (nine-tenths being between 60 and 70 per cent) is not, we believe, a peculiarity of epilepsy, and the significance is discussed elsewhere.[8]

Blood for these measurements was drawn without reference to seizures. Possibly the cerebral circulation is normal between paroxysms, but abnormal just before or during a paroxysm. The observations made by Gibbs, Lennox and Gibbs [1] when a blood flow recorder was inserted in an internal jugular vein showed that there was no decrease in cerebral blood flow before and a great increase during a convulsion. Measurement of the oxygen content is a more quantitative means of judging blood flow. On one occasion we were able to secure blood from an internal jugular vein during a prolonged but rather mild convulsive seizure. The arterial oxygen saturation during the seizure was 93.6 per cent; the saturation of the blood from the internal jugular vein, taken twice during unconsciousness, was 55.3 and 55.8 per cent. Twenty minutes later, when the patient was quiet and conscious, it was 38.9 per cent. Several days later it was 56.1 per cent.

During the comatose state of status epilepticus we have in three instances found the oxygen saturation of the blood from the internal jugular vein to be rather low, but not below the limits found in consciousness.

VENOUS BLOOD FROM THE ARM

In one hundred instances, blood was taken from a vein in the antecubital space. The average oxygen saturation was found to be 64.5 per cent. This figure is definitely lower than that given in published data for healthy persons. Seventy-nine students and laboratory workers

8. Lennox, W. G.: Constancy of the Cerebral Blood Flow, Arch. Neurol. & Psychiat., to be published.

examined by Goldschmidt and Light [9] and Lundsgaard and Möller [10] had an average oxygen saturation of 72.3 per cent, an increase above our average figure of 7.8 per cent.

The distribution of values for the epileptic and healthy groups was compared by means of curves (chart 1). The two curves have a similar form, but the distribution of the epileptic group is consistently lower than that of the healthy group. In other words, the epileptic average is low, not because a few of the samples of blood had very little oxygen, but because all had slightly less than would normally be expected.

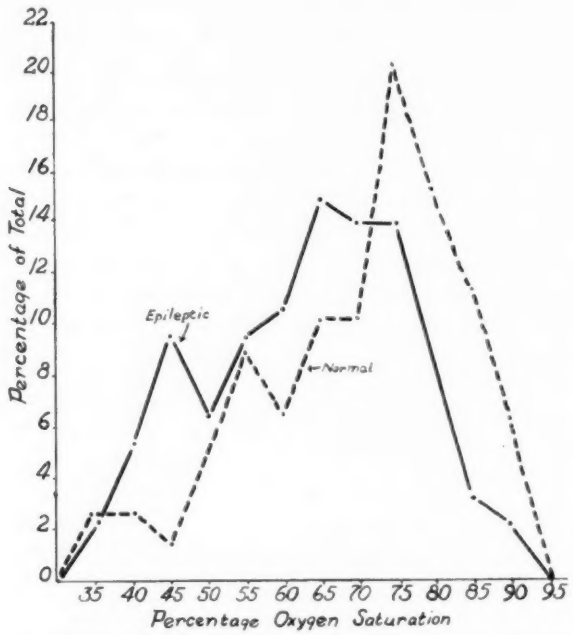

Chart 1.—Percentage distribution of the measurements of oxygen saturation of the blood from an arm vein of ninety-five epileptic and seventy-nine healthy persons. The curve for the epileptic patients is solid, and that for normal persons is broken. The individual measurements are grouped in fives, e. g. (reading from left to right of the abscissa), from 35 to 39.9 per cent, from 40 to 44.9 per cent, etc. The irregularities of the curves are due to the small number of cases.

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9. Goldschmidt, S., and Light, A. S.: A Comparison of the Gaseous Content of Blood from Veins of the Forearm and the Dorsal Surface of the Hand as Indicative of Blood Flow and Metabolic Differences in These Parts, Am. J. Physiol. **73**:127 (June) 1925.

10. Lundsgaard, C., and Möller, E.: Investigations on the Immediate Effect of Heavy Exercise (Stair-Running) on Some Phases of Circulation and Respiration in Normal Individuals; Oxygen and Carbon Dioxide Content of Blood Drawn from Cubital Vein Before and After Exercise, J. Biol. Chem. **55**:315 (Feb.) 1923.

In order to see whether this low average oxygen saturation was peculiar to epileptic persons, we gathered blood from other ward patients with neurologic diseases. The average oxygen saturation for twenty-four such patients was 62.5 volumes per cent. This is even lower than the average for the epileptic patients. Therefore, as in the case of the arterial blood, the oxygen saturation of venous blood from the arm is abnormally low in epileptic patients, but the hypoxemia is not specific.

BLOOD FROM A FEMORAL VEIN

In a group of fifty epileptic patients, the average oxygen saturation of blood from a femoral vein was 68.5 per cent. We do not have

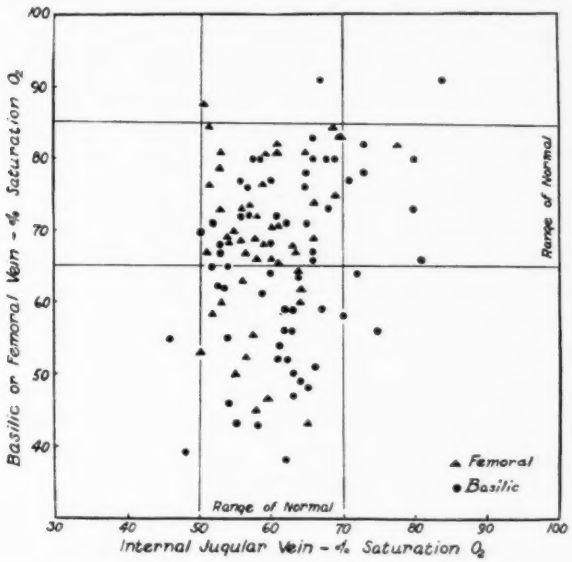

Chart 2.—Distribution of the individual measurements of oxygen saturation in the one hundred and ten patients with epilepsy from whom blood was drawn from both an internal jugular and a basilic or femoral vein. If the blood from the extremity came from a vein in the arm, the dot is circular; if it came from a femoral vein, the dot is triangular. The oxygen saturation in percentage is on the scale at the bottom for blood from the jugular vein and on the side for blood from the vein in the arm or leg.

reported figures of the saturation in healthy persons. In a group of fourteen nonepileptic patients with neurologic disorders, the average was 71.8 per cent (table).

The distribution of individual measurements of the oxygen saturation of one hundred and ten patients who supplied blood from both an internal jugular and a basilic or femoral vein is shown in chart 2. The perpendicular zone on the chart defines the probable limits of nor-

mal of oxygen saturation for blood from an internal jugular vein, i. e., from 50 to 70 per cent. Only two measurements were below this. The horizontal zone of from 65 to 85 per cent (taken from the normal curve of chart 1) shows the probable limits of normal for blood from an extremity. Forty-one of the one hundred and ten measurements were below this normal zone.

The average values for the carbon dioxide content of venous blood were within normal limits in all groups, a fact which is against any distinct shift from normal of the acid-base balance.

COMMENT

The observed mild degree of anoxemia of the venous blood of the arms of epileptic patients is, we believe, the result of a laggard peripheral circulation. Clinical corroboration of this lies in the cold, cyanotic hands which many epileptic patients present, to which, after pressure, the color returns slowly. The condition is due not to insufficient cardiac output but to overactive vasoconstriction, which prevents the quick passage of blood through the capillaries.

The condition is of no consequence except as it is a common accompaniment of poor physique, poor posture, constipation and an inadequately balanced vegetative nervous system. When present, it requires an attempt at correction.

CONCLUSIONS

The oxygen and carbon dioxide content of venous blood has been measured for a large group of epileptic patients, and comparison has been made with values for healthy patients or with those for nonepileptic patients with neurologic disorders.

In one hundred and thirty measurements of the oxygen saturation of blood from an internal jugular vein, the average value was 62.8 per cent. Though this is lower than the oxygen saturation of blood from an extremity, it is believed to be normal.

In one hundred measurements of blood taken from the arm, the average value was 64.5 per cent. Though this value is about the same as that for patients with other neurologic disease, it is significantly lower than the 72.3 per cent average for healthy persons as reported in the literature.

In fifty measurements of blood taken from a femoral vein, the average value was 68.5 per cent.

These results indicate that the speed of the total cerebral blood flow of epileptic persons is probably normal. The blood flow through the arm in most patients is abnormally slow as a result of vasoconstriction of the peripheral vessels. This is probably a concomitant of the poor physique which many patients possess.

PREPSYCHOTIC PERSONALITY OF PATIENTS WITH INVOLUTIONAL MELANCHOLIA

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The clinical impression that patients with involutional melancholia have a uniform prepsychotic personality stimulated a more thorough study to ascertain the extent to which this holds true. As the investigation proceeded, three more or less well defined questions arose: 1. Is there any trait or pattern of traits which can be said to be common to persons in whom involutional melancholia develops later? 2. Does this pattern differ notably from that of the average person? 3. Is this pattern common to all depressive groups or peculiar to that of the involutional type?

In order to have a description of the personality prior to psychotic distortion, only those patients were chosen whose early histories were known in detail. An analogous difficulty presented itself in the study of persons with recurrent manic-depressive attacks. So far as possible the characteristics of the basic personality were obtained.

Although it is the current impression that involutional melancholias and manic-depressive psychoses represent somewhat distinct types of reaction, this impression has not been unanimous. Dreyfus, in 1907, made an exhaustive follow-up study of the eighty-one cases which had prompted Kraepelin to define involutional melancholia. He concluded that this clinical condition was not an entity but merely a late manifestation of a manic-depressive psychosis, basing this conclusion on the history of previous attacks in 54 per cent of the cases and the high incidence (66 per cent) of recovery, even after a protracted course. Kirby,[1] however, in an excellent review of Dreyfus' monograph stated: "In a considerable number of other cases the author's (Dreyfus) conclusion that manic-depressive symptoms were present is based on extremely meagre data."

Despite the acceptance by Kraepelin of Dreyfus' findings and conclusion, involutional melancholia has continued to be described as a distinct entity, with the qualifying statement that it might represent a

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1. Kirby, G. H.: State Hosp. Bull. **1**:459, 1908-1909.

mixed state of a manic-depressive psychosis. Hoch and MacCurdy,[2] MacCurdy,[3] Gillespie [4] and Harrowes,[5] in attempting to classify depressions, have not hesitated to describe involutional melancholia separately. It is discussed as an entity by current textbooks, and Henderson and Gillespie [6] listed as diagnostic features "depression without retardation, anxiety, a feeling of unreality, and hypochondriacal delusions, the last being in the allo-, somato-, and auto-psychic fields." These features offer ordered criteria on which to base a diagnosis so that comparable cases may be studied.

Only one reference to the prepsychotic personality of persons with this type of melancholia has been found. Noyes [7] stated: "In a significant number of cases we find a certain general type of personality make-up and habits of life. A review of the patient's previous personality and temperament often show that he has been an inhibited type of individual with a tendency to be serious, rigid, lacking in humor, and over-conscientious. Often his routine of life has been narrow, somewhat stereotyped and devoid of diversions. Frequently he has been a loyal subordinate, meticulous as to detail, rather than an aggressive leader." This impression was based on personal clinical observations rather than on any statement in the literature or an intensive study carried out under his direction.[8]

MATERIAL AND METHODS

Three groups of ten persons each were selected for this study. Five men and five women presenting clearcut clinical evidence of involutional melancholia, whose histories had been given in each case by one or more dependable informants, were chosen from the larger group admitted to the clinic with this diagnosis. The physicians who recorded the histories were unaware that a special study was contemplated and as a rule followed "A Guide for History Taking and Clinical Examination of Psychiatric Cases," as edited by G. H. Kirby for the state hospitals of New York. The general information regarding these patients is summarized in table 1.

The second group consisted of five men and five women who had not shown frank disorders of personality. They were of an intellectual level approximately equal to that of the previous group; their ages ranged from 26 to 42, the average

2. Hoch, A., and MacCurdy, J. T.: Prognosis of Involutional Melancholia, Arch. Neurol & Psychiat. **7**:1 (Jan.) 1922.

3. MacCurdy, J. T.: The Psychology of Emotion: Morbid and Normal, New York, Harcourt, Brace & Company, 1925.

4. Gillespie, R. D.: Guy's Hosp. Rep. **79**:306 (July) 1929.

5. Harrowes, W. M.: J. Ment. Sc. **79**:235 (April) 1933.

6. Henderson, D. K., and Gillespie, R. D.: A Text-Book of Psychiatry for Students and Practitioners, ed. 3, New York, Oxford University Press, 1932

7. Noyes, A. P.: Modern Clinical Psychiatry, Philadelphia, W. B. Saunders Company, 1934.

8. Noyes, A. P.: Personal communication to the author.

being 34, and an earnest attempt was made to choose a cross-section of general types of personality and to avoid personalities that were pronouncedly either outgoing or withdrawn.

As a third group, ten persons admitted during manic-depressive episodes were chosen. The criteria of choice were: (1) a clearcut clinical picture and (2) an adequate anamnesis antedating the first attack. The general data regarding the patients of this group are summarized in table 2.

From a review of the cases of involutional melancholia, twenty-two traits which each patient exhibited to some degree were selected. The cases under study were then analyzed for each trait and graded from (—) to (++++). This grading was repeated after an interval of several weeks without reference to the

TABLE 1.—*Summary of General Information on First Group of Patients Studied*

Patient	Sex	Age	Occupation	Marital Status	Onset of Illness	Present Status (Feb. 1, 1935)
1	M	56	Physician	M	Jan. 1932	Convalescent (state hospital)
2	M	53	None	M	April 1933	Unimproved (private hospital)
3	F	56	Housewife	M	May 1929	Slightly improved (private hospital)
4	F	54	None	S	Dec. 1933	Unimproved (private hospital)
5	F	50	Housewife	M	Dec. 1929	Recovered (home)
6	F	60	Housewife	M	Aug. 1933	Unimproved (private hospital)
7	M	59	Minister	M	June 1933	Unimproved (private hospital)
8	M	54	Building foreman	M	June 1933	Unimproved (private hospital)
9	M	61	Lawyer	M	Fall 1932	Unimproved (private hospital)
10	F	59	None	M	Fall 1933	Unimproved (private hospital)

TABLE 2.—*Summary of General Information on Third Group of Patients Studied*

Patient	Sex	Age	Occupation	Marital Status	Diagnosis	Present Status
1	F	24	Telephone solicitor	S	Manic state	Recovered
2	F	28	Jewelry designer	S	Manic state	Recovered
3	M	50	Customer's man	D	Manic state	Recovered
4	F	26	Housewife	M	Manic state	Recovered
5	F	28	Housewife	M	Depressive state	Recovered
6	M	28	Postgraduate student	M	Manic state	Recovered
7	M	40	Broker	M	Depressive state	Recovered
8	F	22	Housewife	M	Depressive state	Recovered
9	F	25	None	S	Depressive state	Recovered
10	F	21	Student	S	Manic state	Recovered

previous result, and the two analyses were found to be in close agreement. This process was repeated for each of the control groups. Later seven of the traits were omitted from the final summary when it was found that the control cases differed little in these traits from the cases under study. The omitted traits were: intelligence, decision, self-assertion, pride, ambition, irritability and dependence on family attachments. The traits by which all were finally evaluated were: interests, adjustability, sociability, friendliness, tolerance, sexual adjustment, ethical code, saving, reticence, sensitivity, anxiety, stubbornness, overconscientiousness, meticulosity regarding person and meticulosity regarding work.

In order to avoid misinterpretation, it seems well to define the scope of each of these terms. Interests were judged by breadth and variability rather than by depth and intensity. Adjustability was graded by the person's reaction to both major and minor shifts in environment. Sociability and friendliness were both included because it was thought necessary to distinguish between mere enjoyment of social contacts and the additional virtue of being able to make and hold friends.

Tolerance was evaluated by the ordinary standards, but it was applied to detailed contacts as well as to larger questions. The difficult problem of ascertaining the degree of the sexual adjustment was met as far as possible by combining the evidence from the history and the marital partner with the direct statements and indirect evidence from the patient. The rigidity of the ethical code was determined by the subject's ability to modify his code or to hold it inviolable under changing circumstances. The proclivity for saving was gaged not only by the attitude toward expenditures and luxuries but by the type of investments. Reticence, grading from a reserve in public to a strictly imposed silence as to personal feelings, even with those nearest, was noted. Anxiety was estimated on the basis of its outward manifestations from the worrisome, fretful disposition to the chronic apprehensive and fearful state frequently observed. Stubbornness, or obstinacy, was measured by the tenacity with which the subject adhered to his action or beliefs despite the outward weight of evidence to the contrary. Overconscientiousness in its most pronounced aspect showed itself in fanatical devotion to duty, whether personal or professional. Meticulosity as regards person or work was determined by excessive neatness or more than adequate attention to details.

A brief résumé of the catamnestic data relative to the personality of each patient with involutional melancholia follows:

REPORT OF CASES

CASE 1.—A physician aged 59 was seemingly a very capable and certainly an indefatigable worker, long associated with academic medicine. However, he always seemed to fall just short of the goal which his training and endeavor merited. Rather protected in his youth, unduly attached to his mother, he showed no untoward reaction when she became psychotic and died while he was in college. He achieved a good cultural background, although mainly interested in his profession. He tended to routinize his life, and his adjustments were made with some difficulty. His sexual life was inadequate. Masturbation, begun while he was in medical school and augmented by orgasms obtained at rare intervals while attending burlesque shows, served as sexual outlets even after marriage. He hesitated to enter marriage, breaking one engagement at the age of 42, just two weeks before the contemplated marriage. Four years later, he married a widow, but coitus occurred only rarely and was soon discontinued owing to his impotence. His very stringent ethical code restricted his freedom of action and several years before marriage prohibited indulgence in an affair with a married woman who ardently encouraged such an alliance. Conservative in his expenditures, he also was most cautious in his investments. While he was not particularly reserved so far as his interests and work were concerned, he always withheld personal confidences. He was overanxious for the good opinion of others, markedly sensitive to real and implied slights and at times suspicious of the motives of acquaintances; several times he broke off acquaintanceships of years' duration because of minor slights. He never displayed hypochondriac anxiety, although aware that he had had hypertension for years. Stubborn in maintaining his views, he was ordinarily good-humored until he felt that his code or rights had been transgressed and then he became irate. Detailed, careful work gave him his greatest pleasure. He was assiduous and overmeticulous as to detail but at the same time he was indecisive and required reassurance as to his accuracy. He was decidedly fussy as to his personal appearance.

CASE 2.—The patient, aged 53, scion of a wealthy family, was more or less a dilettante in the family business, with his main interests centered in sports and

philosophy. An overly protected shy and timid child, he became retiring, quiet and indecisive in adolescence and had very few friends. Despite a broad educational background he did not adapt himself easily to new ideas or to environmental changes. While his acquaintances were widespread, he had few or no friends. A seemingly casual appearance of tolerance cloaked a rigid intolerance of any view which threatened his equanimity. Nothing is known of his premarital sexual life. At the age of 43 he married a girl aged 21. Within a short time he became impotent with her, and she divorced him five years after marriage. He drank excessively for several months thereafter. At the age of 51 he married a second girl aged 21, with whom he also became impotent after a few months. While he was generous in public he was niggardly and fussy about minor expenditures in private life. Though he was an able social conversationalist he never gave confidences. His pronounced sensitivity was attributed to his "high-strung nervous disposition." which exhibited itself very often in peevish irritability and obstinacy regarding trivial details. He was fastidious but conservative about his personal appearance and was meticulous about the orderly arrangement of his quarters.

Case 3.—The 56 year old wife of an executive in a steel mill in a midwestern city, prior to her marriage had been completely dominated by the narrow and rigid views of her mother, toward whom she was outwardly completely subservient. During adult life her interests were centered in her home, in which she took great pride, and in a constant round of social engagements. The slightest deviation distressed her markedly. Despite a wide social acquaintanceship she had few or no friends, her animosity being easily aroused. Considered somewhat liberal in her own set, she was intolerant of the slightest deviation from the strict code which she imposed on her daughter. She had married at the age of 25 but derived no pleasure from coitus, and her only sexual outlet was obtained through masturbation, which she practiced throughout adult life. Her husband maintained a protective attitude toward her. She prided herself on her ability to find bargains and was unnecessarily economical. Obstinately opinionated, she was willing to express views on any subject except her own inner thoughts, concerning which she was markedly reticent. When her will was crossed, she frequently had tempestuous but short-lived outbursts of temper. She was constantly anxious about her health and welfare and that of her family, toward each member of which she carefully weighed the extent of her "duty." "Scrupulous" and "perfectionistic" in attending to the details of her "obligations," she was also fastidious about the care of her person.

Case 4.—A woman aged 54, an impoverished and distant relative of a very wealthy family, had become an orphan at the age of 11 after spending the early years of her life exposed to the poverty induced by a dissolute father. Following the death of her parents she spent twenty-five years as the ward of a much older cousin, to whose devout and demanding ways she subjected herself. Any environmental change was resisted, and if such a change became necessary it occasioned a flurry characterized by indecision and a harried scramble to set up a new routine. Her acquaintances were limited and friendships rare as she could not tolerate the presence of a person whose opinion varied from her own. This attitude was an expression of her Victorian outlook on life. Nothing is directly known of her sexual life, but she prolonged a pseudo-engagement to a desirable man for eleven years and then evinced surprise when he married another woman. For almost ten years before the onset of the illness she exhibited an attachment for a young priest, and seemingly followed him when he was transferred to a distant parish. She was always very religious and adhered to a high ethical code.

She was frugal at all times, perhaps secondary to her long dependence on the beneficence of others. She was extremely sensitive and exhibited a marked reserve toward every one. This became a rigid reticence when her inner feelings were involved. Known to be "set in her own way," she became perturbed and sharply irritable when her opinions were crossed. Even though she became disturbed and worried when anything threatened her routine, she exhibited no great concern when diabetes developed and was actually careless in following the regimen set up for it. Always dainty and fastidious, she could not brook the slightest disarray or untidiness about her person or home.

Case 5.—The wife of a political worker, aged 50, during childhood had been subject to the intimidation of an alcoholic father and the excessive supervision of seven older siblings. She made a good record in parochial schools. She was entirely absorbed in her home and her church and limited her activities accordingly. She had no social contacts outside her family and no confidants. Following marriage, at the age of 19, she bore two children and had no desire to have more despite being a devout Catholic. The discussion of sex was taboo in her family, and she refused to advise her children in that. She was at all times undemonstrative toward her husband and children. Personal criticism disturbed her greatly and caused her to retreat into a state of hurt silence. Of a worrisome disposition, she was apprehensive about her health but, at the same time, terrified by the suggestion of seeing a physician. Her "duty" as defined by the Church was complied with in the most scrupulous manner, and she insisted on the utmost neatness and cleanliness regarding her person and her home.

Case 6.—The 60 year old wife of a successful business man in an eastern city as a child had been considered a tomboy. Throughout life she evinced feelings of being inferior because she had not attended college. As an adult she did not extend her interests beyond her home and family, and she had a limited acquaintanceship, with few, if any close friends. She married at the age of 26 and had two daughters; at all times she maintained an undemonstrative, reserved and hypercritical attitude toward them and her husband. Time and again she proved completely intolerant of new ideas relating to the education of her children, especially in psychologic and sociologic fields. She was unduly scrupulous in the budgeting of her household expenses and refused assistance with her housework for many years after such aid was well within her means. Social acquaintances found her reserved on all topics and exceedingly reticent regarding her personal life. However, she constantly assumed that slights had been offered when slights had not been intended and harbored grudges for long periods. She was ever anxious as to the health of her family and was herself treated for many years for vague abdominal complaints. She was accustomed to carry her strict sense of duty into every aspect of her life and was unsparing in criticism of her own shortcomings as well as those of others. She made every effort to be immaculate personally and maintained the spotless condition of her home with equal vigor.

Case 7.—A Baptist minister aged 59 had for several years held an executive position in the mission organization of his church. Immediately after his birth it had been necessary to feed him artificially, and he had been considered a "delicate" infant. His childhood was spent almost exclusively in association with adults, by whom he was known as a "serious-minded boy." A driving interest in his professional work precluded other activities. A forced sociability which was replaced by seclusiveness when he was fatigued, along with a rigid intolerance of dissenting views, prevented the formation of friendships. He married at the age of 28 after an engagement of four years and became the father of four children,

from whom he exacted strict adherence to his views in an almost tyrannical manner. His early financial struggle, in order to obtain an education, was mirrored in the careful manner in which he managed his finances. He seldom departed from his marked reserve and was known to react very sensitively to criticism. He was always tensely anxious about any project which he was conducting, but he never showed worry regarding his physical condition. He had a marked sense of responsibility and was overly critical of himself at the slightest sign of what he termed "weakness." He was known as an assiduous capable worker, an excellent organizer, who achieved results mainly because of his attention to detail.

CASE 8.—A superintendent of building construction aged 54 was interested only in his work, in which he was faithful and adequate although he lacked imagination. He had no recreational activities, preferring to spend his hours away from work sitting taciturnly and seclusively at home. He had few acquaintances and always maintained an attitude of reserve toward them. His subordinates knew him as a driver but at the same time admired him for his energy, efficiency and blunt honesty. Married at the age of 30, he was opposed to having children, and when his wife became pregnant with their second child he flew into a rage. Throughout married life he was demanding and insistent on his will in the home and maintained an undemonstrative attitude toward his family. However, in later years he exhibited signs of jealousy over any attention which his wife bestowed on their son, aged 23. Obstinate to a pronounced degree in his opinions, he became irritable and explosively angry if his will was crossed. Neat in his personal appearance he was careless about his physical health. His rise to an executive position from a humble beginning was attributed to his methodical and conscientious attention to details and unswerving loyalty to his employers.

CASE 9.—A successful lawyer aged 61, of Irish ancestry, prominent throughout his native state, had spent his childhood in straitened circumstances with an irritable penurious father and an ambitious mother who made him her favorite. He was content with a meager law practice in a small city until he was forced by his wife into a more responsible position in a metropolis, where he became rapidly successful despite the appearance of anxiety symptoms at the end of the first year. Limiting his interests to his profession and current events, he resisted any change in his daily routine, and was proud but never boastful of his reputation as an indefatigable worker and as a man of absolute honesty. Distant with acquaintances, reticent and undemonstrative toward his family and disliking social functions, he had few friends. His personal code forbade smoking, drinking or gambling, and he was completely intolerant of and censured those whose personal codes permitted these activities. To the extent that his earnings permitted, he provided for his family generously as far as necessities were concerned, but he classified the automobile and the radio as luxuries and never purchased either for his home. He invested only in government bonds. He married at the age of 32 and never displayed any affection for his wife, being undemonstrative even during coitus, in which he was adequate though in a very mechanical manner. Although a Roman Catholic, he opposed having children and raged when his wife became pregnant with their only child, a daughter. Toward the latter he maintained an impenetrable coolness, never showing affection even when he was noticeably proud of her achievements. He vigorously opposed her marriage, preferring that she have a career, and encouraged separation and divorce at every opportunity. Professionally, he was more than careful that he should attend to the best interests of his clients and refused any case that impinged on his personal code in the

slightest degree. Immaculate in his dress, he made every effort to avoid obesity. His daily routine was ordered to the most minor detail, and any deviation occasioned at least perturbation and even outbursts of temper against the cause of such unwonted interruption.

CASE 10.—A widow aged 57 had limited her interests completely to her investments since her husband's demise when she was about 51 years of age. She was reputed to have been a shy, reserved child. In her early twenties she was forced to adjust herself to psychoses in both of her parents and to the subsequent death of her father. She showed no untoward reaction to those stresses. Although her husband's business required frequent change of residence from one city to another, she was always averse to these changes, adapted herself poorly and made no attempt to become acquainted in a new city. She was considered "cold and unresponsive" because she seemingly cared little for social contacts and had no friends. She was married at the age of 26 and had only one child, a son. Toward him, she was oversolicitous while he was an infant, but thereafter she was indifferent until the time of his marriage. This and a subsequent divorce she opposed; his second marriage aroused her anger and evoked active interference. Whenever the opportunity presented itself, she urged him not to have children. Practically her whole life revolved around speculation in stocks, at which she was shrewd. Ever anxious about her financial security, she was in constant touch with her broker and would not leave her phone during the hours the stock exchange was open. She became obviously disturbed if she suffered losses. She was completely independent in her views, although very reticent about expressing them, and strongly resented any suggestion of intrusion into her private affairs. Along with this attitude she was suspicious of the motives of any person who showed the least curiosity about her. Very critical of others, she was stubbornly set in her own way, especially when it connoted strict attention to detail.

In the evaluation of this group a fairly uniform pattern is seen to exist. The results are shown graphically in table 3. The narrow range of interests, poor facility of adjustment, asocial trends, inability to maintain friendships, intolerance and uniformly poor adult sexual adjustment are constant concomitants of the personality. Likewise the pronounced and rigid ethical code, the proclivity for saving, the profound reticence, the marked sensitivity, the outward evidences of anxiety, the notable stubbornness, the overconscientiousness and the meticulosity in regard to person and work are present to some degree in all the patients. The quantitative estimation from subject to subject is striking even though it varies, but still more notable is the almost constant ratio between the negative and the positive elements in each case.

If the normal group is measured by the same criteria, the different picture shown in table 4 results. Not only does the tendency for a reversal of the positives and negatives in comparison with table 1 become apparent, but the greater variation from subject to subject. In all the normal persons there are a wide range of interests, an ability to adjust to a changing environment, sociability, a capacity for friendship, tolerance and better sexual adjustment. Also the tendency to be notably

TABLE 3.—*Traits of Group with Involutional Melancholia*

Sex	Age	Interests	Adjustability	Sociability	Friendliness	Tolerance	Sexual Adjustment	Ethical Code	Saving	Reticence	Sensitivity	Anxiety	Stubbornness	Overconscientiousness	Meticulosity Regarding Person	Meticulosity Regarding Work
M	56	+++		+	++	+	—	++++	++++	+	++++	++++	+++	++++	++	+++
M	53	+++	++	++	++	++	—	++	++	+	++++	++	++	+++	++++	++
F	56	++	+	++	++	+	—	+	+++	+++	+++	++	++	++	++++	+++
F	54	++	+	+	+	—	—	++++	+++	+++	++++	+++	++++	++++	++++	++++
F	50	+	+	—	+	—	—	+	++	++	++++	+++	++	++++	++++	++++
F	60	+	—	+	—	—	+	+++	+++	+++	++++	+++	++	+++	+++	++++
M	59	+	—	—	—	—	—	++++	++	++++	+++	+++	+++	++++	++++	++++
M	54	—	—	—	—	—	+	+	++	+++	++	+	++++	++++	+	++++
M	61	—	—	—	—	—	+	++++	+++	++++	+++	+	++++	++++	++	++++
F	59	—	—	—	—	—	—	++	++++	++++	++++	++	++++	+++	+++	+++

saving, extremely reticent, anxious about specific matters or in general, overconscientious, and meticulous about the person does not appear.

The result of the study of the manic-depressive group is portrayed in table 5. Again there is no pronounced group conformity to a pattern but a greater individual variation in given traits. There is a general resemblance to the normal group rather than to the involutional group. In contrast to the observations on the involutional group the interests cover a wider field; adjustments are made more easily; sociability and friendliness are more apparent; intolerance is rare, and sexual adjustment varies widely. A propensity for saving is absent; reticence is not so generally evident; sensitivity is not universal; an anxious tone is not ever present, and stubbornness is not prominent. While overconscientiousness and a certain meticulosity appear in individual cases, these traits are not constant.

For the sake of a more concrete comparison, the plus signs accorded to each trait in the three groups have been summated, and the results are presented in the chart in the form of vertical bars. The lack of correlation between group 1 and groups 2 and 3 is shown, as also is the closer symmetry between group 2 and group 3.

What, then, are the personality traits of the person in whom involutional melancholia develops? I shall first discuss the more intelligent person: The public knows him as a strictly honest man who lends dignity and guarantees the integrity of any movement to which he lends his name. The unscrupulous fear him except that they are confident that he will not personally initiate a crusade against them. Persons in difficulty turn to him for practical assistance but do not expect sympathy or an understanding of their plight. His superiors cherish his loyalty and admire his assiduous attention to detail but become exasperated with his lack of imagination and stubborn adherence to routine. Subordinates cannot but admire his efficient application and fairness even though they fear the blunt disfavor with which he regards their deficiencies. Acquaintances are awed by his singleness of purpose and rigid maintenance of ideals but are uncomfortably aware of his lack of humor and of the fact that they are not able to break through his reserve.

As a child he conforms easily to the precepts of his parents to the annoyance of his siblings and other children; in fact, he is the child with the firm and serious outlook on life who is always a comfort to his elders. No sowing of wild oats mars this picture as he becomes adult.

He seeks marriage not for the sake of satisfying emotional needs but only as a further evidence of his conformity to custom. Hence it may be postponed indefinitely because of trivial obstacles or finally con-

TABLE 4.—*Traits of Normal Group*

Sex	Age	Interests	Adjustability	Sociability	Friendliness	Tolerance	Sexual Adjustment	Ethical Code	Saving	Reticence	Sensitivity	Anxiety	Stubbornness	Overconscientiousness	Meticulosity Regarding Person	Meticulosity Regarding Work
F	33	++++	++++	+++	++++	+++	+	++	+	—	+	—	+	—	+	+
M	31	++++	++++	+++	+++	++	+++	++	—	+	+	+	+++	—	—	+
F	38	++++	+++	++++	+++	++++	++	+	—	++	+++	+	++	+	—	+++
F	26	+++	+++	++++	+++	++++	++	++	+	—	++	—	—	—	—	+++
M	33	++++	+++	++++	++++	++++	+	+	+	++	+	—	++	+	+	—
M	30	+++	+++	++++	+++	++++	+++	+	—	—	—	—	—	—	—	—
F	38	++++	++++	++	++	+	+++	+++	+	—	+++	++	+++	+	+	+
M	30	++++	++++	+++	+++	+	+++	+	—	+	++	+	+++	—	—	++
F	42	++	++	+++	++++	++	++	+++	++	—	++	++	+	—	—	—
M	39	++	++	+++	+	++	+++	++	+	+	++	+	+++	+	—	+++

TABLE 5.—*Traits of Manic-Depressive Group*

Sex	Age	Interests	Adjustability	Sociability	Friendliness	Tolerance	Sexual Adjustment	Ethical Code	Saving	Reticence	Sensitivity	Anxiety	Stubbornness	Overconscientiousness	Meticulosity Regarding Person	Meticulosity Regarding Work
F	24	+++	++++	++++	++++	++++	++++	—	—	—	—	—	—	—	—	++
F	28	++	+++	+++	++++	+++	++++	++	—	—	+	—	+	+	—	+++
M	50	+++	+++	++++	++++	+++	+++	—	—	—	+	—	++	++	++	++
F	26	++	+++	+++	+++	++	+++	++	—	+	—	—	—	+	+	+++
F	28	++++	++	++++	++	+++	—	++	—	++	++	+	++	+++	+++	—
M	28	++++	+	++	++	+	++	+++	—	+	+++	+	+++	+++	—	—
M	40	++++	+++	++	++	++	+	+	—	—	+	+	++	++	++	—
F	22	+++	+	+++	++	—	—	+++	+	+++	—	++	—	—	+++	+++
F	25	++	+	++	+++	++	—	++	—	+	++	—	++	+	+	+
F	21	+++	+	+	+	+	—	—	—	+	—	—	+	—	—	—

tracted with great care and without genuine emotional attachment. The wife finds such a husband irreproachable by ordinary standards but inexplicably difficult owing to his insistence on form and his dislike of social contacts. Since his sexual interests are of secondary importance and coitus is merely a manifestation of that which is expected of him, his demands are minimal and without ardor.

Parenthood is a state to be avoided if possible and, if it inadvertently occurs, to be accepted with anxiety rather than enthusiasm. His children become accustomed to finding diffidence where warmth is expected and irritability where sympathy is needed, and they are constantly confronted with an omnipotent being whose greatest attribute

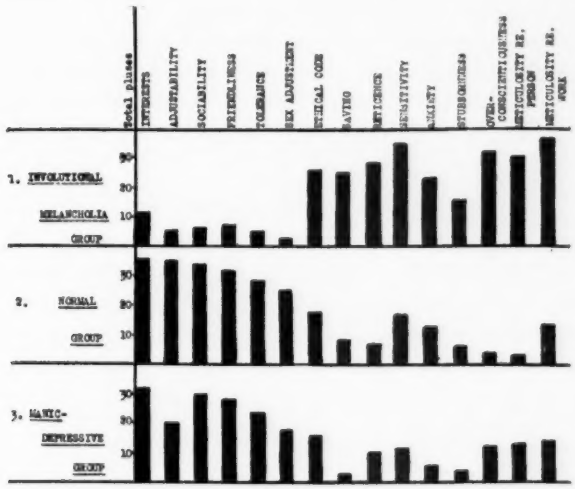

Chart showing the sum of the pulses for each trait as a vertical bar. The contrast between group 1 and groups 2 and 3 is clearly brought out.

is an absolute knowledge of right and wrong. While ordinarily a good provider of the necessities in the home, his financial caution and exaggerated concept of what constitutes a luxury make the household budget a constant problem.

The less intelligent subject is a humdrum person whose life is limited by the sharp confines of the preceding traits and not lightened by the rays of achievement which come to the more intelligent. One might well characterize the group with what is frequently called the "one track mind." All living becomes incorporated within the narrow and artificial limits which are gradually set up. Any threat to these limits is followed by wretchedness or even disaster.

COMMENT

Since the scope of this study has been limited to the descriptive aspects of the prepsychotic personality of the patient with involutional melancholia and to a comparison and contrast of this personality with that observed in the other two defined groups, the dynamic features in relation to the personality or to the illness have been omitted. Detailed data relative to the dynamic aspects of the problem will appear in a future communication.

The general type of personality which has here been found to antedate involutional melancholia has been widely recognized by psychoanalytic writers, notably Freud,[9] Jones [10] and Brill.[11] They have described it as the "anal erotic personality" and traced its relationship to various neurotic and psychotic manifestations of the obsessive-compulsive and depressive states. Muncie [12] discussed "the rigid personality" on the basis of five cases and pointed out "its great significance in the etiology, course and final outcome of psychoses." At the same time he related this type of personality to no particular form of psychosis.

SUMMARY AND CONCLUSION

Study of the prepsychotic personality of a group of patients with involutional melancholia by evaluating the intensity of their outstanding traits shows an almost constant pattern of traits. Narrow range of interests, difficulty in adjusting to change, limited capacity for sociability and friendship, rigid adherence to a high ethical code, marked proclivity for saving, reserve that becomes positive reticence so far as intimate matters are concerned, an ever present anxious tone, profound stubbornness, overwhelming overconscientiousness and strained meticulosity as to person and vocation are constant concomitants of the group.

A comparison of this group with an equal number of normal persons indicates that this pattern is distinct from that of the average personality, especially so far as the arrangement and intensity of these traits are concerned.

The evaluation of a group of patients with manic-depressive episodes by the same standards also presents a sharp contrast. Judged by these traits, the manic-depressive group approaches the normal rather than the involutional group.

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9. Freud, S.: Collected Papers, translated by Joan Rivière, London, Hogarth Press, 1925, vol. 2.

10. Jones, E.: Anal-Erotic Character Traits, Abnorm. Psychol. **13**:261 (Dec.) 1918.

11. Brill: J. Abnorm. Psychol. **7**:302, 1915.

12. Muncie, W.: Rigid Personality as Factor in Psychoses, Arch. Neurol. & Psychiat. **26**:359 (Aug.) 1931.

On the basis of this study it seems that persons in whom involutional melancholia develops have a characteristic pattern of personality. This pattern is distinct from that of the average or that of the manic-depressive type of person.

ABSTRACT OF DISCUSSION

DR. HARRY M. TIEBOUT (by invitation): From the earliest times efforts have been made to define and single out traits and types of reaction and characteristics of a given type of personality. Perhaps the most successful effort was that represented in the study of the prepsychotic personality of patients in the schizophrenic and manic-depressive groups. Now one can think clinically in terms of the schizoid and the manic personality. Adopting much the same sort of technic, Dr. Titley has succeeded, I think, in finding what may be the kernel of the prepsychotic personality of the group with involutional melancholia. It is important to recognize that the histories from which these traits were gathered were not taken by persons with preconception. The examination as found in Kirby's manual was made as a routine; the records show that the responses of the relatives were striking in their uniformity. It is interesting to me to note how, in describing the fifteen traits finally singled out by Dr. Titley, the relatives and other informants used the same words. Dr. Titley's paper opens a question which has been more or less set aside, particularly in recent years, namely: Is there any value in studying the personality? This question has reached the stage that in the last Guide issued by the New York State group personality is put down as a subject which may or may not be included in the history. My feeling is that in a practical sense every one thinks in terms of personality. It is helpful if one has certain definite concepts, and I believe Dr. Titley has made a real contribution in pointing out that the preinvolutional type of personality, which may or may not be closely allied with the anal-erotic personality, is a clinical type which can be recognized. I believe that in a later communication he will tell more of the precipitating elements which should be avoided by these patients, because this type of personality is definitely vulnerable in certain situations, and one can more or less predict at the involutional period whether the mental illness will develop or not.

PHENOMENA RESEMBLING LILLIPUTIAN HALLUCINATIONS IN SCHIZOPHRENIA

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Leroy [1] described a special variety of visual hallucinations which he called lilliputian. They consist of a vision of small people, occasionally accompanied by animals or by other objects of minute size. These phenomena have nothing to do with micropsy. The hallucinations are usually multiple, mobile and of bright color. The patient sometimes hears the small people speaking with a "lilliputian" voice. The hallucinations are usually associated with a pleasant state of mind, rarely having an unpleasant or terrifying effect on the patient. Lilliputian hallucinations have occurred in the most varied conditions: arteriosclerosis, senile psychosis, alcoholic psychosis and most of the toxic and toxi-infectious states (typhoid, cholera, erysipelas, pneumonia, purulent pluerisy, etc.). They are observed occasionally in dreams and in the hypnagogic state. Various drugs—ether, cocaine, alcohol, hashish, hyoscine,[2] caffeine citrate [3]—can produce lilliputian hallucinations. Few cases of lilliputian hallucinations have been reported in the literature on schizophrenia.[4]

In this paper are reported three cases of schizophrenia in which there were phenomena similar to lilliputian hallucinations. The phenomena observed in these cases were essentially different from typical lilliputian hallucinations. The nature of genuine lilliputian hallucinations is not of primary concern here; rather an attempt will be made to evaluate the phenomena which have some resemblance to lilliputian hallucinations seen in such cases of schizophrenia as these.

From the Research Service of the Worcester State Hospital.

1. R. Leroy has published several articles on the subject in French and the following two in English: The Syndrome of Lilliputian Hallucinations, J. Nerv. & Ment. Dis. **56**:325, 1922; The Affective States in Lilliputian Hallucinations, J. Ment. Sc. **72**:179, 1926.

2. Vonderahe, A. R.: Lilliputian Hallucinations: Report of a Case of Hyoscine Poisoning, Arch. Neurol. & Psychiat. **22**:585 (Sept.) 1929.

3. Work, P.: Lilliputian Hallucinations Following the Use of Caffeine Citrate, Arch. Neurol. & Psychiat. **24**:143 (July) 1930.

4. Demay, G., and Beaudouin, H.: Hallucinations lilliputiennes dans un syndrome hébéphrénique, Ann. méd.-psychol. **84**:57, 1926. Leroy, M. R.: Hallucinations lilliputiennes dans un cas de démence précoce, ibid. **84**:63, 1926. Hühnerfeld, F.: Ueber einen Fall von Schizophrenie mit mikropsischen Halluzinationen, Psychiat.-neurol. Wchnschr. **34**:644, 1932.

REPORT OF CASES

CASE 1.—A. D., a white man aged 31, who was admitted to the Worcester State Hospital in 1928, had always been a slow, dreamy, sensitive person. During the two years preceding admission he gradually became more seclusive and depressed. He has various symptoms of depersonalization which are very striking. He feels that his "personality is like a shadow on the ground," "like a stick of wood in the wind"; pointing to himself he says: "That is only my name, not me." Most of his complaints refer to the experience that he is divided into many persons who interfere with each other. For example, he says: "I am half. I am 50 per cent somebody else. There is an extra one, another A. D." (patient's name). "You ask questions from me, and the other answers it." "I can't do anything; if I want to do something they abstract it from me and add it to the other." Pointing to himself he says: "This person is not the same any more. Every day another person comes in this room." "They put me in two or three parts, in two or three figures." "They knock me in so many pieces that I can't get hold of myself."

Closely connected with the experience of division of personality is an experience of foreign, mostly motor, influences. The patient complains: "They grab with my hand; my hand is their hand." "It is not I who am doing it; they are doing it, and I am getting it." "They make my feet go. They start me; they stop me; they have a good time." "I don't laugh; somebody makes me laugh; my skin laughs." "I can't think. They think in my head; they are using all my thinking apparatus." "I am not angry. The anger is just there, but it doesn't come from my system." The feelings of sympathy are also greatly impaired in him. He refers to his mother as "the woman I lived with" and to his father as "the man who brought me to the hospital" or "the white-headed man." He states that he does not feel that his parents and siblings are related to him; he says: "I can call that woman mother, but she is not related to me. There is no love in it." He makes numerous somatic complaints. He feels that his body is falling apart, that his trunk is empty, that he cannot keep food, that it disappears immediately. He complains that "some stuff" is emanating from his body, that parts of his body are dead, that his "teeth are not grown in but only set in." He feels that the "floor is not steady enough" but moves up and down under his feet, that he is going up into the air or sinking into the ground. He has many auditory hallucinations. The "voices" often seem to come from different parts of his body, such as his stomach or his knee. He often states that he cannot hear the voices with his ears but hears them with his feet. He also has marked disturbances of activity characterized by great indecision and retardation of movement.

The patient often states that there are small people in his abdomen. Usually there is only one at a time there, but sometimes there are two or three. At other times he feels that these small fellows are running through his body, through his limbs. Occasionally he claims that these little persons are his relatives, mostly his brother William. He indicates the size of these people differently on different occasions as between 1 and 10 inches (2.5 and 25 cm.). He states occasionally that the "little fellows" in his body "expand and contract like rubber." When he was asked whether he saw the little fellows also outside his body, he stated that he saw them once on the field shortly before admission. They had little colored coats on. He sometimes states that he also has little horses in his stomach.

CASE 2.—H. A., a white man aged 29, was admitted to the Worcester State Hospital in 1933. During the three previous years he increasingly lost interest in work, and for a few weeks he did not leave the house. He claimed that his

parents were not his real parents. He thought that he was a crown prince. He had auditory hallucinations and many bizarre somatic complaints.

The patient has the experience of his person being divided, "as if I had two or three people with me." He complains that somebody tries to "copy" him, that there is a second H. A., who interferes with him. He says that "they" try to control him, that he feels like a "mechanical man." When he eats, he has the impression that another head is inside his head and that this eats with him. He says that somebody else makes him do things. He complains that parts of his body are dead, that his ribs and his jaws are "set in." His teeth are "false," his skin is "papery," the inside of his body is empty, he has only a "frame," the food does not remain in his body but "disappears," "evaporates." Often he feels that his body is too light and goes up into the air, that it expands and contracts "like an accordion," that some light substance is emanating from his body. He states that he hears "silent voices" which seem to come from his own body.

The patient claims that he has little people, about 5 inches (15 cm.) tall, in his stomach, who speak to him with "little voices." He thinks that with a stethoscope the examiner too could hear these voices. Among these small people there is one, a little girl, who calls herself "Depth Koda," of whom he speaks often. He states that it is "hard to see" the small people. They are "invisible like air," but one can feel them on the body, and one can hear them talking. He also has the impression that little angels are flying up from his shoulders and from his back, and once he felt that a butterfly was flying up from his chest. Another time he stated that "little spirits" were talking in him and were working on his body.

Case 3.—H. F., a white man aged 22, who was admitted to the Worcester State Hospital in 1934, had been an active boy, especially in competitive sports, and was well liked by his companions. The first signs of illness were noted about eight or nine months previous to admission. He seemed to be confused; his speech became incoherent; he began to read the Bible a great deal, and he complained of hearing voices.

The patient is confused most of the time; his speech is rambling and often incoherent. He has vague delusions, mostly of religious content. He says that the first sentence of the Bible is the key to every riddle. He states that when he reads or thinks of foreign countries and historical events, he seems to remember actually having been there. He complains that different personalities are within him, that he has a "dual complex." He has the impression of motor influences. He states that "a lot of acrobatics are going on" in his body. He says: "I have the sensation that people are trying to trip me a lot; my feet seem to be tangled up with somebody else's feet. Now and then I sort of make a move on my own account, not very often though." "They" command him to "turn around, do this, do that." He makes many somatic complaints. He feels that parts of his body "disappear," "fade away," that "something like wind" is emanating from almost every part of his body. His head feels "light," his arm seems to be "dead" and does not seem to be his own. His body seems to be falling apart. When walking, he sometimes has the impression of stepping on parts of human bodies. He complains of voices coming from all over his body. The contents of the auditory hallucinations are sometimes obscene remarks; mainly, however, they are commands, like "turn your head," "raise your shoulder" and "move your arm." He states that the commands are given by voices which come from small people inside his body. These "small fellows" are also able to move around in his body. When questioned closely, he states that he never saw these small people; he has only the "impression" that they are small. He also feels that little angels, which are light "like wind," are running up and down in his arm.

COMMENT

All three patients report hallucinatory experiences of small persons and, less frequently, of small animals. The small size of the objects perceived in these hallucinations could suggest that they are identical with lilliputian hallucinations. On the other hand, the hallucinations of these schizophrenic patients differ essentially from typical lilliputian hallucinations as they are described in the literature. There are two most important differences:

1. Whereas the true lilliputian hallucinations are localized in external space, these schizophrenic patients experience the small figures as inside the body or sometimes as in close contact with the surface of the body. Only one of the three patients (case 1) has perhaps had on one occasion in the past a vision of small people localized in external space. He is not certain on this point. During the period of observation this patient always reported experiencing the small people within his body.

2. The true lilliputian hallucinations are always vivid, colorful and rich in sensory qualities. The hallucinatory experiences reported by these patients, on the other hand, are hazy and indefinite. It is doubtful whether, in these phenomena, visual elements are at all involved. The patient in case 2 reports that it is "hard to see" these small people, "they are invisible like air." The patient in case 1 occasionally states that he "sees" the small people. Such statements, however, must be taken from this patient with caution, since he often speaks of experiences which at first seem to be visual hallucinations but which on closer analysis evidently are not; for example, he once reported having seen a horse in the corridor. When he was asked whether he saw the horse with his eyes, he replied, "Not exactly, but I could smell it in the air." When asked: "Did you smell the odor of horse?" he answered: "No, I *sensed* it in the atmosphere; I *knew* that there was a horse there."

Kinesthetic experiences seem to be definitely related to these phenomena. This is most clearly evident in case 3. The patient says that he cannot see the small people, but he feels them definitely working on his body. They move his arms and legs, twist his shoulders, turn his head. The experience of motor influences is an expression of a particular disturbance of self-awareness. This disturbance is that the experiences of the patient lose their usual relation to the ego and the patient is impressed by his own activities not as his own but as done to him by some foreign force. All three patients reported the impression of another person in their bodies, who interfered with their activities. The "second person," or the influencer, being himself, experienced, usually inside the body, the idea may easily arise that he must be of a small size; otherwise he would not have enough room within the body. This is not invariably so, however, since the same patients often com-

plain of motor influences without connecting them with the idea of small people as the cause of the influence.

The patients are rather indefinite about the size of the small people, since they indicate their size differently on different occasions. The patient in case 3 is especially vague on this point. When he was asked how he knows that these people are small, he replied: "I don't know, they might also be big, but I have the impression that they are small." On other later occasions, however, he again referred to "small people" as the cause of the influences.

As has been pointed out in other papers,[5] the motor influences of schizophrenic patients give rise to a group of somatic sensations. These sensations, for example, that of some light substance passing through and emanating from the body and the impression of contraction and expansion in different parts of the body, seem also to contribute to the patient's complaint. The patient in case 2 tells of small angels flying out of his shoulders and back and of butterflies flying up from his chest. These might well be delusional elaborations of the sensation of some light substance emanating from his body. This is a common experience of this patient. The patient in case 1 complains of small people running through his limbs and that the small fellows expand and contract in his body like rubber. These phenomena might well be due to somatic sensations, already referred to, namely, those of some substance which is passing through the body or of parts of the body expanding and contracting.

Probably auditory components also play a prominent part in producing the phenomena of "lilliputian hallucinations" in these schizophrenic patients. They often report that they hear the little fellows talking. The sounds are often faint and feeble voices ("silent voices," "little voices"). This might also contribute to the patient's idea that the producer of these "little voices" must be of small size. The patient in case 2 sometimes imitated these voices to the examiner by high-pitched whispering. All three patients have reported that they hear voices coming out of the inside of their bodies. An adequate term for this phenomenon may be auditory hallucinations with endosomatic localization. The patient in case 1 hears the voices coming from the floor through his feet. He hears them from his knee and arms and occasionally from his stomach. The patient in case 2 hears the voices from his stomach and from his feet. The patient in case 3 hears them from all over his body. The endosomatic localization, like the feebleness of the voices, also may suggest to the patient that the people from whom the voices come must be small.

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5. Angyal, A.: The Perceptual Basis of Somatic Delusions in a Case of Schizophrenia, Arch. Neurol. & Psychiat. **34**:270 (Aug.) 1935; The Experience of the Body-Self in Schizophrenia, ibid. **35**:1029 (May) 1936.

There must be a close connection between the kinesthetic experience of motor influence and the endosomatic localization of these auditory hallucinations. In my personal experience there cannot be recalled the existence of endosomatic localization of auditory hallucinations in any patient in whom motor influences did not also occur. The reports of the patients also point to a close connection between these phenomena. This is shown especially clearly by the patient in case 3, who makes use of the expressions "they move my arm" and "they tell me to move my arm" interchangeably. This connection can be understood in the light of the specific characteristics of schizophrenic hallucinations, which differ greatly from the hallucinations of alcoholic persons, for example, or from any other kind of so-called "organic hallucinations." There is good basis for the opinion that the typical schizophrenic hallucinations do not differ to any great extent from thoughts, images and other experiences of normal persons so far as the vividness and richness of sensory qualities are concerned. The chief differences consist probably in the altered structure of experience which is caused by a disturbance of self-awareness. These patients probably imagine, act and think in a way similar to that of normal persons, but they do not experience themselves as the cause of imagining, thinking and acting; rather these experiences impress them as coming from outside themselves, as something objective. In other words, the experiences lose their usual relation to the ego.

When, for example, a patient has the impulse to move his arm, he does not experience it as his own impulse because of the disturbance of self-awareness. He has the impression that somebody else tries to move his arm or suggests to him that he should move his arm. This may have a verbalized form. Gruhle[6] discussed the phenomenon of endosomatic localization of auditory hallucinations in the example of a patient who heard voices coming from his shoulder:

> The patient doesn't mean by this, for example, that he hears the voices from the region of his shoulder, but he evidently has simultaneously with the hearing of voices sensations in the shoulder also. The assumption suggests itself that two simultaneous impressive experiences are fused into one experience because of the simultaneity. This is not absolutely necessary, however. If a patient suffering from rheumatism once gets a stomach-ache, he will not fuse this pain and the joint pains.

Gruhle refrained from making even a tentative hypothesis on the subject, because he observed cases in which "a patient suffering from voices had at the same time somatic sensations and yet did not fuse the two into a whole."

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6. Gruhle, H. W.: Die Psychopathologie, in Bumke, O.: Handbuch der Geisteskrankheiten, Berlin, Julius Springer, 1932, vol. 9, footnote 146.

I agree with Gruhle in the view that the simultaneous presence of two sensory experiences, for example an auditory and a kinesthetic one, is not a sufficient basis for the fusion. If the explanation already given is correct, one must assume that it is not a phenomenon of fusion at all, but that the motor influence and the auditory hallucination are two different manifestations or components of the same unitary experience; the patient experiences his dissociated and objectivated impulse as a motor influence, or as a verbal suggestion, or as both. This explains also why patients may have somatic sensations and auditory hallucinations without connecting them in any way. It is, of course, possible that the endosomatic localization of auditory hallucinations can be ascribed to other factors, but the mechanism referred to seems to be the most likely one.

On the basis of the foregoing remarks one may conclude that in his complaints of small people the schizophrenic patient refers to quite a different type of experience from that of true lilliputian hallucinations. Rather, auditory hallucinations and the experience of motor influences seem to form the basis for this complaint. The small size is presumably suggested by the localization of the auditory hallucinations and motor influences to the inside of the body. However, one cannot exclude the possibility that, besides these factors, conflicts or "complexes" which are possibly operating beneath the manifest symptom complex also provide some material for the patient's complaints about small people.

There are not sufficient data at hand to affirm or deny that true lilliputian hallucinations occur in schizophrenia. There are a few cases reported in the literature.[4] They are probably extremely rare.

In comparing the three cases reported in this paper, one is impressed by the fact that apart from the "lilliputian" hallucinations these patients also show great similarity in their general clinical picture. Their principal common symptomatologic features are the following: 1. A profound disturbance of self-awareness which gives rise to many complaints, among which the most important is the feeling of being divided into two or more persons. 2. Experience of motor influences ("They move my arms." "They move me around." "They turn my head.") and the impression of passivity ("I feel like a mechanical man."). 3. Certain somatic complaints which, as was pointed out in other papers,[5] are based on kinesthetic sensations and are due to changes of the muscle tonus. It was then pointed out that the changes of muscle tonus are derived from motor influences. 4. Auditory hallucinations with endosomatic localization.

On the basis of an extensive study with this type of patient, the impression is gained that this group of symptoms have intimate interrelations. They are not likely to occur by themselves but rather in association with each other. The phenomena which resemble lillipu-

tian hallucinations seem to be frequent but not constant components of this complex of symptoms. The question whether or not one is justified in calling this association of symptoms a "syndrome" will be discussed in another paper.

SUMMARY

Three cases of schizophrenic patients with complaints of hallucinatory experiences of small people are reported.

It is pointed out that these phenomena differ essentially from the true lilliputian hallucinations met with in other conditions in that (1) while the true lilliputian hallucinations are localized in external space, the schizophrenic patient experiences the small people inside his body, and (2) while the true lilliputian hallucinations are vivid, colorful and rich in sensory qualities, the experiences reported by schizophrenic patients are hazy and indefinite.

The phenomena seem to be based largely on the experience of motor influences and of auditory hallucinations. The small size is presumably suggested by the endosomatic localization of the "voices," and of the motor influences.

There appears to be a close relationship between the endosomatic localization of auditory hallucinations and the experience of motor influences. They are regarded here as different manifestations of a dissociated impulse.

The patients with these hallucinations present a great similarity in the rest of the mental symptomatology also. All three patients had the following symptoms: (1) an impression of a division of personality, (2) motor influences, (3) somatic sensations on a kinesthetic basis and (4) auditory hallucinations with endosomatic localization.

It may be worth while to consider the question whether the association of these symptoms constitutes a syndrome.

HEMIEDEMA IN CASES OF HEMIPLEGIA

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Marked edema localized to the paralyzed side in cases of hemiplegia arouses curiosity and stimulates inquiry concerning the mechanism of its causation; it particularly raises the question of the existence of cerebral vasomotor centers of contralateral dominion. The literature on hemiedema in cases of hemiplegia has been relatively meager. In 1899 Parhon and Goldstein stated that they had observed hemiedema eight times in eighty-seven cases of hemiplegia. Pierre Marie in 1901 wrote that although congestion and fulness of the paralyzed hand were often observed in cases of hemiplegia, genuine edema limited to the paralyzed side sometimes occurred. He stated, "J'en ai moi-même observé plusiers cas" [I myself have observed several cases], and thus indirectly implied its rarity. Dejerine, in speaking of edema sometimes encountered on the paralyzed side in cases of focal cerebral lesions, wrote: "Il s'agit là du reste d'un phénomène rarement observé" [It is, moreover, a phenomenon rarely observed]. More recently, Stone said that unilateral edema either was not found or was not recorded in a group of five hundred cases of hemiplegia observed in the neurologic service of a large general hospital.

A review of the available literature on hemiedema in cases of hemiplegia revealed reports of fifteen cases with postmortem observations since 1886 (Banti, Gombault, Préobrajenski, Hare, Marinesco, Allen, Parhon and Goldstein [eight cases] and Stone) and of thirteen more without postmortem observations (Nothnagel, Gilbert and Garnier, Loeper and Crouzon [three cases], Raymond and Courtellemont, Klippel and Pierre-Weil, Deumié, Durand, Lewandowsky, and Mirallié [three cases]). In these cases the ages of the patients (stated in twenty-one instances) ranged from 24 to 76 years, the median age being 56. The time of onset (stated in twelve cases) varied from "with paralysis, a precocious type of onset," to thirty years after the appearance of the hemiplegia, the median time being six weeks after the onset of the paralysis. The observed period of duration (stated in seventeen cases) varied from ten days to a year, with a median of two months. Associated cardiac or renal disease, manifested either during life (clinically) or at autopsy, was found in every case in which ample data were fur-

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nished, with the possible exception of two cases (reported by Raymond and Courtellemont and by Klippel and Pierre-Weil). The eight cases of Parhon and Goldstein, which are frequently cited in the literature, were meagerly described from the standpoint of possible myocardial insufficiency, and postmortem observations on the heart and kidneys were not furnished except for two patients. One of these patients suffered from aneurysm of the aorta, and the other, a man aged 67, presented at autopsy signs of chronic myocarditis and changes incident to prostatism. In two of Parhon and Goldstein's cases, reported originally in 1899, the hemiedema was considered to be of purely "nervous" origin (without any underlying basis of cardiac or renal disease), but the only information given concerning the integrity of the heart and the kidneys was that the urine contained neither albumin nor sugar. In five cases of the group of twenty-eight there was bilateral edema only of the lower extremities, with a much more pronounced edema of both upper and lower extremities on the hemiplegic side (Nothnagel, Gilbert and Garnier, Loeper and Crouzon [case 2], Klippel and Pierre-Weil, Parhon's thesis [case 3] and Mirallié [case 1]). In Stone's case bilateral edema of cardiac origin existed, but "shortly after" the onset of hemiplegia the edema became localized to the paralyzed side.

In most of the cases in which postmortem observations were reported the central nervous system was the site of rather extensive lesions of cerebral softening. However, in Gombault's case "alternating" hemiplegia (the left side of the face and the right extremities) and right hemiedema were associated with softening in the caudal portion of the left side of the pons (including both the tegmental and the basilar portion thereof) and a walnut-sized meningioma (?) in the left sphenoid fossa; the myocardium, incidentally, showed many sclerous plaques. The patient was a man aged 76, in whom the "precocious edema" developed with the suddenly appearing paralysis. In Klippel and Pierre-Weil's case, also, although autopsy was not performed, the hemiparesis was the residuum of a quadriplegia caused apparently by trauma to the spinal cord. In eleven of the fourteen cases in which the hemiplegia was of cerebral origin, the internal capsule was directly included in the area of softening. In four cases the anterior segment alone was involved; in four more, the posterior segment alone, and in three, both the anterior and the posterior segment. The internal capsule was not directly involved in three cases (Preobrajenski's case, in which there occurred acute hemorrhagic internal pachymeningitis, softening in the right caudate nucleus, multiple lesions with slight softening in the right caudate nucleus and multiple lesions with slight softening in the cortex and white matter below; Marinesco's case, in which there was involvement of the white substance of the opposite rolandic con-

volutions, and Parhon's case 4 [reported in his thesis], in which there was a large, continuous area of softening in the right parietal lobe, beginning behind the ascending parietal convolution, plus softening in the right lenticular nucleus). The lenticular nucleus was involved in eleven cases, and the caudate nucleus was affected in eight. An example of the changes in the brain, which is representative for the whole series, is presented by Parhon and Goldstein's case (1) in which the hemiedema was thought to be of purely nervous origin. There was softening of the anterior segment and knee of the internal capsule on the left side, involving also the anterior part of the caudate nucleus and the internal part of the lenticular nucleus, with small foci of disseminated softening in the centrum ovale, corresponding to the temporal and occipital lobes. Degeneration of the right crossed pyramidal tract in the medulla was also noted.

In addition to these cases, there have been reports in the literature of edema or localized vasomotor disturbances attributable to the effects of focal cerebral lesions. Thus, Kaiser in 1895 described the occurrence of a swollen, livid condition of the right extremities in a woman, aged 69, who was afflicted with an organic dementia. No obvious hemiplegia was associated with the vasomotor disturbance. Necropsy revealed, besides general atrophy of the brain on an arteriosclerotic basis, foci of softening in the contralateral supramarginal gyrus and in the caudate and lenticular nuclei. Kaiser hypothesized that the caudate nucleus functions as a vasomotor center for the opposite half of the body. In the same year, Rossolimo reported the case of a man, aged 38, who had a cyanotic, edematous condition of the left hand in addition to paresis on the left side and convulsive seizures. At operation, a cyst of the right motor area was removed, after which the vasomotor disturbance disappeared. Oppenheim, in his textbook, mentioned that he had observed cases of vasomotor jacksonian epilepsy. Gordon has described a case of nonpitting, trophic edema limited to one hand, with all of the characteristics of the main succulente described in cases of syringomyelia, which occurred several weeks after a cerebral attack manifested by the development of astereognosis with reference to the affected hand. The diagnosis was made of a vascular lesion of the (contralateral) superior parietal lobule (or in the supramarginal gyrus), and the suggestion was advanced that this sensory cortical center might exercise trophic functions as well. Wichert reported the case of a girl who presented, in addition to epileptic seizures, a cyanotic, edematous condition of the right hand. Postmortem examination of the brain revealed an old glial scar in the region of the motor center for the right hand. Recently, Bucy described a case of suddenly developing right hemiplegia with abolition of pulse and blood pressure on that side,

followed by rapid recovery. In this article Bucy reviewed the literature dealing with supposed vasomotor changes in cases of hemiplegia. Fulton observed that after destruction of the premotor area in the monkey certain vasomotor changes appear on the contralateral side, including transient edema. Kennard studied these changes in greater detail and found a definite lowering of the temperature of the skin of the contralateral side of the body. This change in temperature persisted in chimpanzees for a longer time (up to six months) than in monkeys.

REPORT OF CASES

CASE 1.—*Mild hemiparesis and hemiedema in a demented, ambulatory man aged 76.*

J. F. D., aged 76, who lived alone in Chicago, had become increasingly forgetful during the past few years. He had been found wandering aimlessly about the streets. The patient was referred by relatives for consultation on June 19, 1931, when psychiatric examination revealed a state of marked dementia. Although the patient was able to walk and all movements of the extremities were possible, examination revealed mild, spastic left hemiparesis. The left upper extremity was obviously swollen, especially distally, with obliteration of the spaces between the knuckles, the comparative circumferences of the hands being 20.5 cm. for the right hand and 23 cm. for the left. The left leg and foot showed mild pitting edema, with the following circumstances at corresponding points above the ankles: right, 21.5 cm.; left, 23 cm. The heart was moderately enlarged and there was a systolic murmur at the base. There was no arrhythmia. The peripheral arteries were conspicuously arteriosclerotic. The blood pressure was 130 systolic and 70 diastolic. Three months later the patient died of "chronic myocarditis." The edema persisted, localized to the paretic side, until death.

CASE 2.—*Long-standing hemiplegia and hemiedema in an epileptic patient; evidence of renal insufficiency.*

Mrs. J. A., aged 43, a housewife, was admitted to the Cook County Hospital on July 12, 1933, in a confused state following an epileptic seizure. Since the age of 24 she had suffered from periodic seizures of grand mal type followed by periods of confusion. These attacks had been recurring about once a month. Approximately eleven years before admission paralysis of the left side developed, three days after the birth of a child.

Examination at the time of her admission to the hospital revealed spastic left hemiplegia. The heart was apparently normal on physical examination. The blood pressure was 115 systolic and 66 diastolic. The lungs were normal. The liver was not palpable. The red blood cells numbered 3,710,000 per cubic millimeter, and the hemoglobin content was 50 per cent (Tallqvist); the white blood corpuscles numbered 6,800. Wassermann tests of the blood and spinal fluid gave negative results. A roentgenogram of the skull revealed nothing abnormal. Unfortunately, no record of urinalysis appeared in the history. The urea nitrogen content on July 13 was 23.8 mg. per hundred cubic centimeters, and the creatinine content, 1.75 mg. The hospital record stated that elephantiasis was present in the lower extremities and that there was pitting on pressure (edema) over the lower half of the left leg. A dermatologist noted that the patient said that she had had swelling of the left leg ever since the paralytic attack eleven years before. He found an edematous swelling of the left leg below the knee and a "similar

lymphatic edema of the left forearm and hand, with reticular, livid mottling of the extensor surface of the left forearm and acrocyanosis of the fingers."

The patient was not seen by me during the period of her first admission. She returned to the hospital on Aug. 24, 1933, in a state of confusion and stupor which followed an epileptic seizure. Examination on the day of her readmission revealed lethargy, and disorientation for time and place. There was an old spastic left hemiparesis, rather complete in the upper extremity and of moderate degree in the lower extremity, where all movements were possible but weak and spastic. The patient had incontinence of urine. The left hand and forearm had an edematous, pudgy appearance. The skin over these parts appeared abnormally smooth and white, and the depressions between the knuckles were almost obliterated. There was no pitting on pressure in this upper extremity. The left lower extremity was edematous below the knee and showed pitting on pressure. Both lower extremities were very stocky, but the right was not edematous.

The patient was removed from the hospital a few days later against advice, and her present whereabouts could not be traced.

CASE 3.—*Thyrotoxic and hypertensive (?) heart disease, with congestive decompensation. Thyroidectomy; postoperative development of hemiplegia followed by marked hemiedema. Gradual but incomplete subsidence of hemiedema with improvement in the condition of the heart.*

Mrs. J. K., aged 48, had symptoms of thyrotoxicosis about seven years before the present examination. She underwent partial thyroidectomy, with subsequent disappearance of symptoms. A recurrence of thyrotoxicosis, marked by a train of symptoms including progressing weakness and irritability, dyspnea, palpitation and edema of the ankles and legs, led to the performance of a second subtotal thyroidectomy on Feb. 8, 1933. Study of the perfunctory hospital records covering the period of hospitalization for the second operation revealed no record of a preoperative physical examination. On the first postoperative day the patient complained of weakness in the right arm. This weakness gradually became less, but on the afternoon of the fifth postoperative day she suddenly lost the power of speech and the use of the right extremities, without losing consciousness. The blood pressure in the right arm was found to be 190 systolic and 96 diastolic. A few days after the "stroke" marked pitting edema of the whole right lower extremity (including the thigh) developed, with obvious swelling of the right upper extremity and with no gross swelling of the contralateral extremities. The hospital records revealed a number of comparative blood pressure readings for the two arms, the first of these having been recorded three days after the onset of the hemiplegia. In none of the determinations did the differences in blood pressure in the two arms exceed 6 mm. of mercury. The highest blood pressure was recorded on the eleventh postoperative day (202 systolic and 112 diastolic), and the lowest, two weeks later (150 systolic and 94 diastolic). After a few weeks the hemiedema became much less pronounced.

The patient was examined by me on September 19, more than seven months after the onset of the hemiplegia. She was still confined to bed or to a wheel chair, suffering from a spastic right hemiparesis. A profound motor aphasia, not without some sensory aphasic disturbance, was found. It was evident that the patient retained sensibility to pain, touch and vibration on the right side but that these sensations were probably impaired. There was a slight degree of cardiac enlargement on palpation and percussion. No murmurs and no disturbances of rhythm were found. The blood pressure was 140 systolic and 80 diastolic. There

were cyanotic swelling of the right hand and slight pitting edema over the right tibia, whereas the left extremities were normal in these respects. The comparative circumferences of the calves were: right, 37.5 cm.; left, 36 cm.

CASE 4.—*Hypertensive and arteriosclerotic heart disease, with preponderant hypertrophy of the right ventricle and arteriosclerosis of the pulmonary artery. Severe congestive decompensation, with symmetrical edema. Sudden cerebral vascular accident, followed within a few hours by a shift of the edema to the paralyzed side. Persistence of marked hemiedema till death, a month later. Encephalomalacia in the centrum semiovale of one hemisphere, extending into the precentral and postcentral gyri, without direct involvement of the basal ganglia.*

Mrs. B. F., a widow aged 48, was first examined on Oct. 20, 1930, at her home. She was suffering from an acute cardiac decompensation of congestive type, with orthopnea, dependent edema and hypertension. She was admitted to the Illinois Masonic Hospital on Nov. 11. Examination revealed: cyanosis and orthopnea, with an extreme degree of generalized water-logging; massive pitting edema of the feet, ankles, legs, thighs, abdomen and back, of symmetrical distribution; slight bilateral hydrothorax, more marked on the right, and a relatively slight degree of shifting dulness in the flanks (ascites). There were moist râles at the base of each lung, and the tender edge of the liver was 4 fingerbreadths below the costal margin. The blood pressure was 190 systolic and 160 diastolic in the right arm and 210 systolic and 165 diastolic in the left arm. The pulse rate was regular (82), and there was no pulse deficit at the time of this examination, but in the course of the patient's hospitalization a tendency toward pulsus alternans developed. The border of the left side of the heart extended almost to the midaxillary line beneath the fifth rib; a heaving and somewhat diffused apex beat was felt, and a systolic murmur was heard at the apex. A very strong accentuation of the second pulmonic sound was audible. The second aortic sound was loud, but less so than the second pulmonic sound. The radial arteries were only slightly thickened. Marked retinal arteriosclerosis was seen in the fundi. No objective evidence of neurologic disease was found. The specific gravity of the urine ranged from 1.008 to 1.014 and there were heavy traces of albumin, with occasional granular casts. The nonprotein nitrogen content of the blood was 34 mg. per hundred cubic centimeters, and the creatinine content, 1.5 mg. An electrocardiogram revealed clearcut right ventricular preponderance and slight slurring in the QRS complexes of all three leads. The hemoglobin content (Tallqvist) was 80 per cent; the red cells numbered 4,900,000 and the leukocytes, 10,600 per cubic millimeter.

The edema largely subsided under treatment in the hospital during the ensuing two weeks, but the other objective evidence of cardiovascular disease remained almost unchanged. The patient returned home, where she gradually became worse, and a moderate degree of pitting edema developed in the lower extremities.

On the afternoon of Jan. 9, 1931, about six weeks after the patient had returned home from the hospital, she suddenly screamed, became cyanotic and found herself unable to move the left arm. For an hour thereafter she was incapable of speech. When she was examined that evening, about two hours after the sudden onset of the cerebral accident, she presented objective evidence of flaccid left hemiplegia. The left arm and leg were slightly edematous, whereas no obvious edema or pitting was noted on the right except about the buttocks and flanks. The patient was in a very anxious frame of mind, rendering finer tests of sensibility of questionable value; however, sensation to pain was considerably diminished in the left upper extremity and questionably so in the left

lower extremity; vibratory sense was apparently absent in the left arm and leg. The patient was right-handed and right-eyed. No aphasia was demonstrable.

The cardiac decompensation rapidly grew worse. The edema became more prominent and remained limited to the left side of the body until about two weeks before death, when the right flank and the upper part of the right thigh became edematous (but less so than on the left side). The edema was of the pitting type, especially over the tibia. The skin of the swollen forearm and hand was pale and smooth. Although the edema fluctuated in intensity from day to day, it persisted till death, four weeks after the onset of the hemiplegia and hemiedema. Change of posture had little if any influence on it. The usual posture assumed by the patient was that of dorsal decubitus, with the upper part of the body propped up on several pillows.

Two weeks after the onset of hemiplegia there was a slight return of motor power in the left upper extremity, but movements were limited to the shoulder and elbow. Slight flexion of the left hip, knee and toes was possible. The hemiplegia had become spastic. There were hypalgesia and hypesthesia of the whole left side, especially over the extremities, but the anxious and distressed condition of the patient partially invalidated these apparent sensory findings. The edema of the left hand had become worse, with obliteration of the spaces between the knuckles. There was marked pitting edema of the left flank, beginning at the fifth rib. The skin of the left breast was edematous. There was slight edema of the right flank and of the upper part of the right thigh, but no edema of the right leg, ankle and foot. The left lower extremity was swollen, and its pale, indurated skin pitted on pressure.

The patient died on February 5. An autopsy was performed in the undertaker's rooms after the body had been embalmed with a fluid which contained formaldehyde. The thoracic and abdominal viscera were examined macroscopically by Prof. J. P. Simonds of Northwestern University. Unfortunately, microscopic sections of organs other than the brain were not obtained. Eight hours after death the following circumferential measurements were noted: right instep, 21 cm.; left instep, 26 cm.; right calf, 26 cm.; left calf, 35 cm.; midportion of right thigh, 42; midportion of left thigh, 53 cm.; right hand, 18 cm.; left hand, 19 cm.; right forearm, 17.5 cm.; left forearm, 20 cm.; right arm, 23 cm.; left arm, 22 cm. The left breast appeared larger than the right, and the left labium majus was swollen to approximately twice the normal size (as compared with its nonedematous fellow).

The anatomic diagnosis was: hypertrophy and dilatation of the heart (the heart was greatly dilated and weighed 590 Gm.; the myocardium of the right ventricle was hypertrophied proportionately more than that of the left ventricle, and there was no valvular lesion); marked arteriosclerosis of the pulmonary artery; decided atheromatosis and arteriosclerosis of the aorta and cerebral arteries; chronic passive hyperemia of the liver, spleen and kidneys; bilateral hydrothorax (more marked on the right); a small mural thrombus in the right auricle; recent infarcts of the left lung and right kidney; suspected chronic arteriosclerotic nephritis (the kidneys were enlarged, hyperemic and hard, with capsules slightly adherent and the cortices of normal thickness); encephalomalacia in the right cerebral hemisphere; subcutaneous edema of the left side of the body, exclusive of the face; hypostatic pulmonary congestion; multiple fibromyomas of the uterus; a persistent thymus gland, and hyperplasia of the mediastinal lymph glands. The femoral and axillary vessels of both sides showed no thrombosis or embolism.

The brain was studied by Dr. Arthur Weil, of the Institute of Neurology of Northwestern University. After fixation in a solution of formaldehyde for three weeks, the brain weighed 1,515 Gm. The basilar and internal carotid arteries showed atheromatous changes, but the middle cerebral arteries at the base appeared macroscopically normal. In the lower third of the right precentral and postcentral gyri the brain tissue was retracted and softened. The meninges appeared normal. The brain was sectioned coronally, and three adjacent large blocks, including the softened area, were embedded in pyroxylin. After a few sections had been cut on the sartorius microtome from each of these blocks, the remaining portions were divided into smaller parts and sectioned serially at 30 microns. Every fifteenth section was stained with cresyl violet and every thirtieth section by Weil's method. Examination showed encephalomalacia, predominantly of the anemic type, in the centrum semiovale of the right hemisphere, extending to the surface of the brain in the region of the lower portions of the precentral

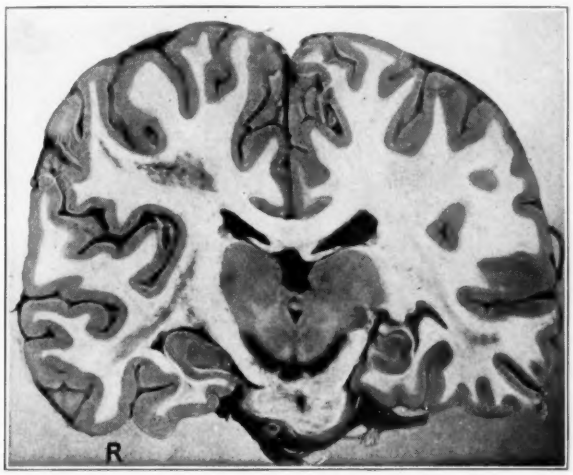

Fig. 1 (case 4).—Posterior surface of a coronal section of the brain.

and postcentral gyri. The caudate and lentiform nuclei, the thalamus, the hypothalamus and the internal capsule were not directly involved in the softening. The extent of the lesion may be seen from the photographs of the frontal sections and the drawing showing the area of the lesion in a horizontal plane.

CASE 5.—*Hypertensive disease, complicated by small, localized cerebral hemorrhage. Coma, with flaccid immobility of the extremities. Progressive cardiac failure and a fall in the blood pressure associated with the developement of mild edema of the leg contralateral to the cerebral lesion.*

Mrs. A. C., aged 48, was seen in consultation on Oct. 16, 1933. She was then in a deep stupor. About six months previously the systolic blood pressure had been over 300 mm. of mercury, and both of the lower extremities showed slight pitting edema. On October 6, when seen in her physician's office she showed no abnormal neurologic signs. The blood pressure was 194 systolic and 106 diastolic. She was advised to stay in bed. During the ensuing week the family noted that the patient was drowsy most of the time. Examination on October 16 revealed her to be in a stuporous condition, with an axillary temperature of 102.4 F. on the

right side and 102.1 F. on the left. The blood pressure was 206 systolic and 114 diastolic in the right arm, and 190 systolic and 116 diastolic in the left. The pulse rate was 102; the pulsations were regular except for intermittency caused by occasional extrasystoles. The heart was slightly enlarged. A systolic murmur was heard over the apex. Examination of the right ocular fundus revealed high grade arteriosclerotic changes, plus a star-shaped figure in the macular region. There was a barely perceptible edema of the left foot and leg. The urine showed albumin (2 plus), no sugar and a moderate number of hyaline and granular casts. The blood contained 28 mg. of nonprotein nitrogen per hundred cubic centimeters. Neurologic examination revealed equivocal and varying findings from time to time with respect to flaccidity of the extremities and no discernible facial weakness, but the right leg withdrew from a painful stimulus, whereas the left did not, and the plantar response was normal on the right side and equivocal on the left. The next day the patient became deeply comatose; the blood pressure progressively

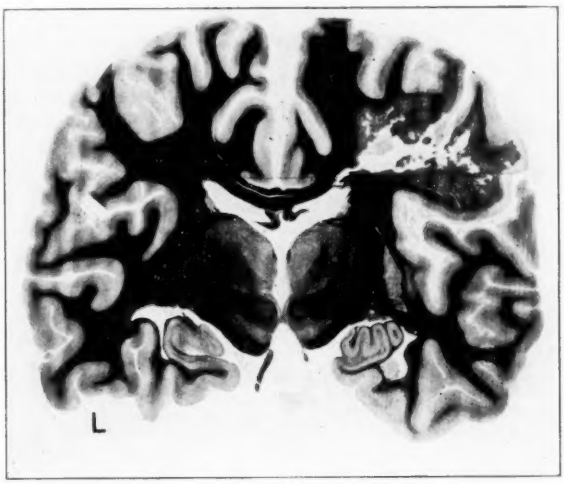

Fig. 2 (case 4).—Coronal section of the brain, stained for myelin by Weil's method, showing the extent of the softening on the right side.

fell, becoming 148 systolic and 74 diastolic at 11 a. m. and 98 systolic and 60 diastolic later that afternoon. The edema (present only in the left leg) increased pari passu with the failure of the heart and became distinctly of the pitting type. All the while the patient's extremities remained symmetrically immobile, in the flaccid paralysis of deep coma.

Postmortem examination, limited to the brain, revealed an apoplectic cyst, probably at least several days old, at the level of the anterior commissure in the coronal section, occupying part of the internal capsule and the corona radiata.

CASE 6.—*Subacute bacterial endocarditis superimposed on long-standing rheumatic mitral disease, complicated by severe hemiplegia due to cerebral embolism. No edema on admission to the hospital. An increase of dyspnea and showers of petechiae correlated with the appearance of edema in the paralyzed leg. Disappearance of edema with improvement in the condition of the heart.*

Mrs. A. B., a woman, aged 38, who was admitted to the Cook County Hospital on Sept. 9, 1933, had been ill for about four months, with weakness, swelling of

the feet and occasional attacks of vomiting. When she awakened on the morning of admission she was paralyzed on the right side and unable to speak. In addition to right hemiplegia and hemihypalgesia, the heart was distinctly enlarged, with a double murmur over the mitral area and a presystolic thrill. The cardiac rhythm was of the sinus type, with occasional extrasystoles. The blood pressure was 120 systolic and 68 diastolic. The liver was enlarged. Slight clubbing of the fingers and toes was present. No edema was noted at the time of admission. There was fever, usually intermittent, with elevations of temperature in the afternoon, ordi-

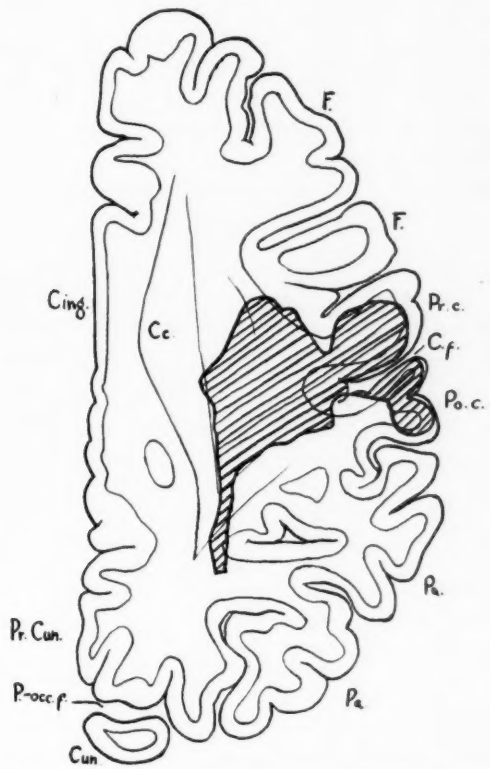

Fig. 3 (case 4).—Drawing showing reconstruction of the lesion in horizontal section, at the level of horizontal section 35 in Dejerine's atlas (Anatomie des centres nerveux, Paris, Rueff et Cie, 1895). This drawing was based on figure 219, page 388, in this atlas.

narily to 100.4 F. On several occasions the urine was normal. Cultures of the blood yielded a tardy growth of chains of gram-positive diplococci, which could not be propagated in subculture.

On October 8, a marked shower of petechiae appeared in the region of the left forearm and hand, and examination revealed discrete petechiae scattered about most of the surface of the body. In the course of routine examination of the series of hemiplegic subjects to be described, I examined this patient on October 9. She exhibited severe right hemiplegia (grade 4 in both the arm and the leg) and

was unable to speak. She also seemed unable to understand simple questions and commands, even in her native tongue (Polish). The left hand showed slight fulness but was the site of an almost confluent aggregation of petechial spots. The right hand was not edematous and appeared somewhat atrophic in contrast to the left. There was a moderate degree of soft pitting edema of the right foot and leg, without any swelling, however, in the left lower extremity. The comparative circumferences were: the right instep, 22 cm.; the left instep, 21 cm.; the right calf (maximum), 25.5 cm.; the left calf, 21.5 cm.; the right wrist, 14 cm.; the left wrist, 13.5 cm. The patient was moderately dyspneic. The objective cardiac findings remained essentially unchanged. The radial pulse felt equally strong on the two sides. The spleen could not be felt. A specimen of urine collected at this time revealed no abnormal constituents.

The patient was seen again one week later (October 16), when the edema was found to have disappeared entirely. The petechial rash had largely faded. The spleen had become palpable. The patient was less dyspneic than when the edema had been in evidence.

CASE 7.—*Bilateral pendant edema of cardiac origin, first noticed eighteen months after the onset of a mild hemiplegia. Edema always distinctly worse in the paretic extremity.*

J. Q., a man aged 73, was suffering from left hemiparesis of two and one-half years' duration. The degree of paralysis was relatively slight (grade 2 in the upper extremity and grade 1 in the lower extremity), and the state of ambulation was good (grade A). The patient was found to have a pitting edema of the distal parts of both lower extremities, that on the left side being more severe. He was examined at 3:30 p. m. The circumferences just above the ankles were: left, 24 cm.; right, 22 cm. The patient related that this edema had been present for only a year. The onset therefore was one and one-half years after that of the paralysis. He also stated that the edema was always worse toward the close of the day and better or even absent after a night's rest; furthermore, it was always distinctly worse in the paretic extremity. The blood pressure, essentially equal in the two arms, was 178 systolic and 90 diastolic. There was moderate enlargement of the heart, with a systolic blow at the apex; the liver was tender and enlarged, and the electrocardiogram revealed an intraventricular block.

After the first four cases just described had been encountered, a series of one hundred patients with hemiplegia were selected at random and examined for the purpose of determining the gross frequency of vasomotor disturbances in cases of recent and in those of long-standing hemiplegia. These subjects were patients in the Cook County Hospital and the Oak Forest Infirmary. In every instance the hemiplegia occurred after some cerebral vascular accident. The duration of the hemiplegia ranged from two days to thirty years, the median duration being two and seven-tenths years. Eighty-two of the patients were males and eighteen females. The hemiplegia was on the left side in fifty-one cases and on the right side in forty-nine. The severity of the paralysis was estimated on a basis of from 1 to 4 plus. In 25 per cent of the cases the incapacity of the upper extremity was from 1 to 2 plus, and in 75 per cent, 3 or 4 plus, while the lower grades of disability occurred in the inferior extremity in 63 per cent and the higher grades

in 37 per cent. With respect to the state of ambulation, 53 per cent of the patients were graded as A or B (able to walk alone without or with a cane), and 47 per cent as C or D (the last group, 25 per cent, being bedridden).

In this series of one hundred cases some degree (usually slight) of hemiplegic main succulente was found at the time of examination in thirteen subjects, and in only two of these was there any pitting edema in the hemiplegic lower extremity. Complaint that the paralyzed hand (or the foot, too) was "always cold" or was colder than the normal counterpart was voiced by eighteen patients. In most of these cases objective verification of such complaints was possible (because of cyanosis and coldness of the part to touch). Actual pitting edema localized exclusively to the hemiplegic side was found only in one instance, case 6, already described. In three more cases (including case 7) there was pitting edema of the lower extremities, which was definitely greater on the paretic side and associated in two cases with main succulente.

There were only two cases in the series in which dependent edema of bilaterally equal intensity was encountered at the time of this survey. The first of these belongs more properly to the group of cases of cerebral monoplegia than to the group of cases of hemiplegia, for although slight weakness of the lower part of the left side of the face and severe spastic paralysis of the left upper extremity existed, the left lower extremity showed practically no disability and no abnormal objective neurologic signs. In the second case there was mild dependent edema of the legs of cardiac origin, coming on eight months after the onset of the paralysis, together with mild hemiplegia main succulente. There was a reliable history of considerable swelling of the hemiplegic upper extremity, which came on "soon after" the paralysis and lasted a few weeks.

There were eleven more cases in this series selected at random in which a reliable history of edema limited to the paretic extremities (ten cases) or of edema which was decidedly more marked in the paretic leg (one case) was elicited. Eight of these patients had well marked hypertensive cardiovascular disease, with evidence of myocardial damage demonstrable either clinically or by inference from electrocardiographic abnormalities. In two more cases obvious cardiac disease, with auricular fibrillation, was found. The remaining case was that of a man, aged 68, who showed no significant cardiovascular abnormalities (apart from peripheral arteriosclerosis) on physical examination or in the electrocardiogram but whose condition was complicated by the presence of a healed varicose ulcer affecting the paretic leg.

In respect to the frequency of edema on the paralyzed side, some degree of hemiedema or of edema which was more marked on the hemiplegic side at some time during the course of the patient's life was

found in 15 per cent of the series of cases. In a given group of hemiplegic subjects the frequency of hemiedema at a given time may be small, but it will probably vary directly as the incidence of congestive decompensation varies. Thus it is significant that in the whole series edema of bilaterally symmetrical intensity and distribution occurred in only two instances, and in one of these the condition was not strictly hemiparesis but cerebral faciobrachial monoplegia, while in the other case there was a history of marked hemiplegic main succulente. The point of view set forth by Pierre Marie, that hemiedema in association with hemiplegia occurs only in subjects suffering from cardiac or renal disease, finds confirmation in these cases. Such an opinion was voiced at a later period also by Mirallié, who stated that the concept of edema of purely nervous origin ought to be rejected as the existence of this type of edema in cases of hemiplegia remains to be proved. In accordance with these ideas, the relation of the onset of hemiedema to that of hemiplegia becomes significant; usually the edema either antedated the paralysis or occurred after a considerable interval. In the latter event no evidence of further progression of the lesion of the nerves was found to explain the tardy development of hemiedema. These considerations suggest that, at the most, the lesion of the nervous system may be responsible for the asymmetrical distribution of the edema in cases of hemiplegia; that is, it may play a localizing rôle. Thus, in case 4, a prior bilateral edema (of cardiac origin) was shifted to the paralyzed side with the onset of hemiplegia and in case 6, in which initial dependent bilateral edema (in the previously nonhemiplegic, ambulatory patient) disappeared with rest in bed, exacerbation of the illness with cardiac embarrassment caused edema to develop on the paralyzed side. Lewandowsky has referred to a remarkable case, in which the patient had almost recovered from the effects of an apoplectic stroke and in whom the first sign of cardiac decompensation due to myocardial insufficiency was the appearance of edema on the previously hemiplegic side.

Granting for the sake of the argument the premise that a former general disturbance of fluid equilibrium (or predisposition to edema) is necessary for the development of pitting edema in a patient with hemiplegia, what causes this tendency for the edema to become selectively localized in the paretic extremities? It has been pointed out that vasomotor disturbances exclusive of actual edema (such as "the succulent hand") are of common occurrence in cases of hemiplegia. What objective evidence is there of this?

Féré, Sicard and Guillain and Tixier were the first to study the blood pressure on the two sides in hemiplegic subjects, according to Durand, and each of them on examination of small groups of patients found a relative hypotension on the paralyzed side in most instances

Peritz reported finding slightly augmented blood pressure and increased sweating contralateral to the side of gunshot wounds of the cerebral cortex in two cases. Mirallié, in a series of twenty cases of hemiplegia found lowering of the systolic arterial pressure to the extent of 10 or 20 mm. of mercury and a plain diminution of the oscillometric index on the paralyzed side. This series included three cases in which there was hemiedema. Rotky and Klein, in a series of fourteen cases of hemiplegia (from one day to three months' duration), found no consistent differences between the arterial pressures on the two sides. In general, the venous pressure was higher and the capillary pressure was lower on the hemiplegic side. Evidence of capillary stasis was more marked on the paretic side. Villaret, in a study of twenty-six cases, found the venous pressure to be distinctly augmented on the paralyzed side in cases of flaccid hemiplegia and diminished in cases of spastic hemiplegia. Pérrison has studied disturbances of sympathetic innervation in cases of hemiplegia. It should be mentioned at this point that none of these investigators used control subjects in his comparative quantitative studies of the circulation on the two sides of the body. Fischer observed differences as high as 30 mm. of mercury in the arterial pressure of the two arms of healthy persons.

Granting again for the sake of the argument the disputed premise that the status of the blood circulation in the paralyzed limbs in cases of hemiplegia frequently differs from that of the normal extremities, the question arises: Are such changes dependent to some degree on nervous vasomotor changes traceable to the contralateral cerebral lesion, or are they purely the result of mechanical influences (diminished active movement with consequent deficiency of venous return, dependent or cramped postures, abnormal muscle tonus, etc.)? Lewandowsky's case, already cited, argues for the existence in his patient of some nervous vasomotor influence. Similarly, case 5 of my series has the same import.

The pathologic changes in the brain in case 4 of my series are significant in that although the lesion is fairly extensive it does not directly implicate the striatum, the thalamus and the hypothalamus. This is interesting in view of the conclusion of Parhon and Goldstein that the striate bodies, especially the head of the caudate nucleus, contain vasomotor centers. In fact, an analysis of the neuropathologic changes in cases of hemiplegia with hemiedema reveals that the cerebral lesions are not essentially different in situation from those generally found in cases of hemiplegia without edema.

CONCLUSIONS

Hemiedema, or edema more marked on the paralyzed side, occurring at some time during the course of hemiplegia, was noted in fifteen of one hundred unselected cases of hemiplegia. However, such edema is

usually mild; marked edema of the paralyzed extremities rarely occurs. The edema per se is probably of cardiac or of renal origin. The cerebral lesion effects a tendency to localize actual or potential edema to the paretic extremities. There is clinical evidence to suggest that some of the circulatory disturbances in hemiplegic limbs may be of cerebral vasomotor origin, quite apart from the purely mechanical factors inseparably linked with the hemiparesis; but thus far the results of clinical studies which were checked with postmortem observations have not furnished any critical evidence for localizing a cerebral vasomotor center of contralateral dominion.

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ARHINENCEPHALY WITH EXTREME EVERSION OF THE END-BRAIN

AN ANATOMIC STUDY

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Arhinencephaly, a malformation of the brain, is closely related in its pathologic process and genesis to cyclopia. Though not particularly common, it appears in a fairly wide range of variations. The case here reported is of special interest because there were among other anomalies an extreme degree of eversion of the end-brain and a relative reduction in the size of the basal ganglia.

REPORT OF A CASE

History.—A girl, born at full term by spontaneous delivery, became intensely cyanotic one hour after birth. Three hours later she was brought to the hospital. On examination there were intense cyanosis, moderate exophthalmos and tense fontanels. A lumbar puncture yielded frankly bloody fluid. The infant took feedings fairly well but did not gain weight; she died on the fourth day after admission. The mother of the infant was said to have received some injections. Wassermann tests of her blood, however, and those of the father's blood were negative.

Necropsy.—Gross Description: The brain measured 10.5 cm. in length and 8.5 cm. in its greatest width. Viewed from above, the end-brain appeared as a crescent or horseshoe-shaped mass with a big dorsal defect which measured 5 cm. in length and 4 cm. in width (fig. 1*A*). The defect opened into a large unpaired ventricular cavity which showed evidence of a marked degree of hydrocephalus. The ventricular floor in the median line was raised into a shallow keel-like longitudinal ridge, lateral to which there were some irregular slight impressions. Caudally the thalami bulged out in the shape of two oval masses, separated in the midline by a narrow groove corresponding to the third ventricle. The space between the caudal end of the thalamus and the cerebellum was filled with thickened membranous adhesions apparently belonging to the meninges. The cerebellum was of normal size and exposed owing to the lack of occipital lobes. The septum pellucidum was absent, and the corpus callosum and the fornix could not be recognized at first sight, but on closer examination it was found that the marginal

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arch of the ventricles at the rostral part of the horseshoe was a rudimentary splenium continuous with the lateral marginal arches corresponding to the crura, or rather the fimbria, of the fornix.

The lateral and ventral views showed only a rudimentary lateral fissure and an incompletely formed temporal lobe on each side. The division into hemispheres was suggested only by a poorly developed longitudinal fissure at the rostral end. It ran in a ventrocaudal direction, without, however, completely separating the two hemispheres of the end-brain except directly at the frontal pole (fig. 1*B*). The pattern of the gyri and sulci was not quite identical for the two hemispheres (fig. 2). The sulci X, Y and Z of the right hemisphere were frankly irregular. X was probably a combination of the central and the superior frontal sulcus and Y of the precentral and the middle frontal sulcus. The calcarine fissure could not

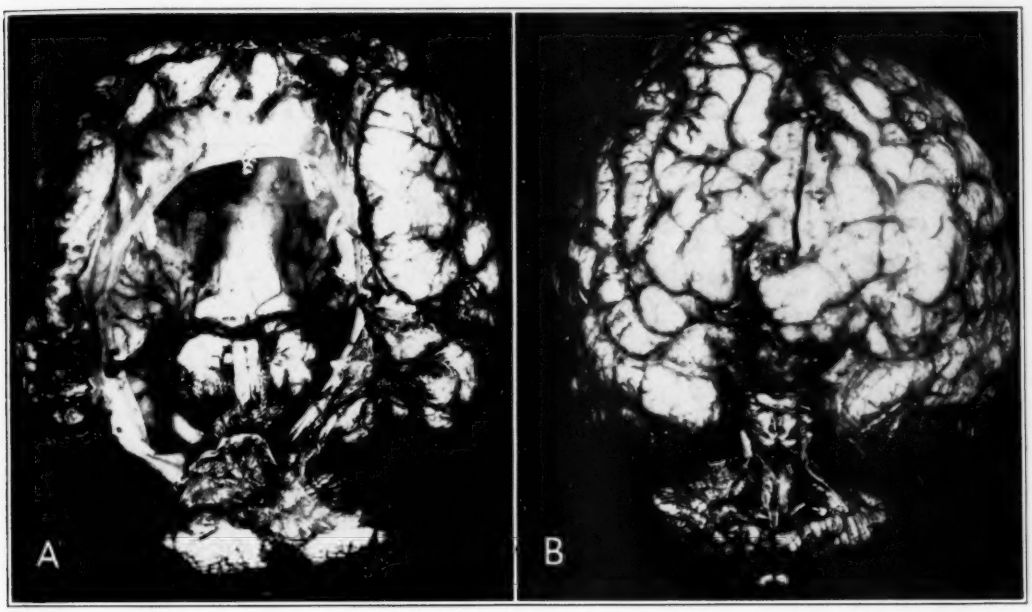


Fig. 1.—*A*, dorsal surface of the arhinencephalic brain; *B*, ventral surface of the arhinencephalic brain.

be identified, nor was it possible to identify the parieto-occipital fissure. The latter observations corroborate the already mentioned lack of an occipital lobe.

On the ventral aspect of the brain the salient feature was the complete absence of the olfactory bulb and tract, as well as that of the trigonum olfactorium, of the several striae olfactoriae and of the diagonal band of Broca. This defect establishes the case as one of arhinencephaly and agrees completely with the other common findings associated with such a defective brain.

The optic tracts and optic chiasm, though undersized, were of fairly normal shape. The infundibulum with the hypophysis was not found. The diencephalic floor caudal to the optic chiasm and including the rostral half of the mamillary bodies had been broken off during the removal of the brain. Thus, the floor of the third ventricle was torn, carrying with it part of the posterior perforated space.

The paired cranial nerves from the third to the twelfth were identified and showed no gross abnormalities.

The pons appeared normal in outline but was somewhat undersized in the region of the middle cerebellar peduncles.

The medulla oblongata showed on its ventral surface the absence of the pyramids, with the result that the inferior olives appeared more prominent.

MICROSCOPIC EXAMINATION OF THE BRAIN [1]

A. General Morphologic Features (Description of Selected Sections).—Section 120 (fig. 3) shows the frontal part of the hemispheres. In this region the two

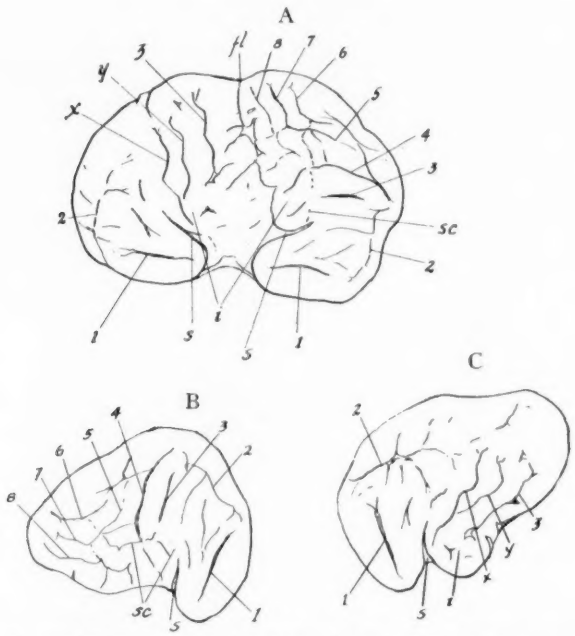


Fig. 2.—*A*, semidiagrammatic drawing of the sulci and gyri projected on a basal horizontal plane; *B* and *C*, semidiagrammatic drawings of the sulci projecting on a lateral plane. The following structures are depicted: *1*, sulcus temporalis superior; *2*, sulcus interparietalis; *3*, sulcus postcentralis; *4*, sulcus centralis; *5*, sulcus praecentralis; *6*, sulcus frontalis superior; *7*, sulcus frontalis medius; *8*, sulcus frontalis inferior; *i*, insula Reilii; *s*, fossa Sylvii; *sc*, sulcus circularis Reilii; *x*, *y*, *z*, irregular sulci; *fl*, fissura longitudinalis.

hemispheres are distinctly separated by the longitudinal fissure. On the left side a small cystlike recess is seen, suggesting an abortive horn of the lateral ventricle. The two hemispheres together form a peculiar crescent-like shape with dorsal

1. After a cast of the brain was prepared, the whole brain was embedded in pyroxylin and then cut into serial sections alternating between 20 and 50 microns in thickness. The thinner sections were stained by the Nissl method, while the thicker ones were stained with a modified myelin stain. A total of 1,800 sections were thus prepared and studied.

concavity. In this dorsal concavity there can be noted remains of a strong membranous wall which shows the same structure as the ventricular lining. From successive sections it may be concluded that a part of the dorsomedial wall of the hemispheres remained as an epithelial structure and bulged out, in front and dorsally as well as caudally, as a huge membranous sac which probably adhered to the meninges and was torn when the brain was removed. This sac formed the roof of the big ventricular opening referred to in the gross description. The end-brain ventricle was most probably closed during life, except where it communicated with the third ventricle, as will be shown later.

In the comment it will be shown that such a protruding membranous sac, formed by a part of the roof of the brain, is common in arhinencephalic or cyclopian brains. The remnants of the wall of the sac, easily traced in serial sections in our case, make it possible to follow the attachment of this roof better than in the cases described before. The pressure of this sac filled with cerebrospinal fluid explains the bowl-shaped concavity of the end-brain.

The ventricular lining shows pathologic changes also observed in other cases of hydrocephalus (ependymitis and subependymal gliosis). The normally single layer of ependyma is replaced by several layers of flattened cells; between these cells and the white substance there is a thick layer of glial tissue.

In section 240 (fig. 4) the fissura longitudinalis is no longer seen; the ventricle has become unpaired; on the right side a rudimentary lateral ventricle becomes confluent with the large common vesicle of the end-brain.

In section 320 (fig. 5) the roof of the vesicle of the end-brain contains commissural fibers which, occurring in this part of the roof and formed of a portion of the lamina terminalis, can be readily identified as a rudimentary corpus callosum.

On the left side a distinct hippocampal formation (cornu ammonis) can be seen. Near the surface of the corpus callosum scattered large multipolar and smaller ganglion cells form a thin sheet of gray substance corresponding to the indusium verum. Highly interesting is the fact that here is found a well developed hippocampal formation above the dorsal commissure (corpus callosum), as in lower mammals (the so-called supracommissural hippocampus of marsupials, edentates and chiropters).

On the left side a part of the dorsal surface of the corpus callosum is covered with ependymal lining, and the attachment of the hydrocephalic membranous sac to the corpus callosum is readily recognized.

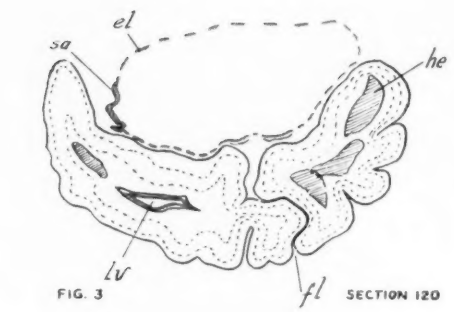
Section 340 (fig. 6) presents the caudal end of the rudimentary corpus callosum.

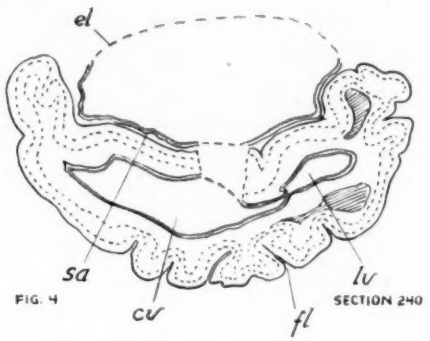
Section 720 (fig. 7) represents a typical section of the middle part of the vesicle of the end-brain. The unpaired ventricle opens dorsally into the distended membranous sac. The dorsomedial edge of the telencephalic wall is represented on both sides by a well developed hippocampal formation composed of the cornu ammonis and the fascia dentata accompanied by the fimbria fornicis (fig. 15).

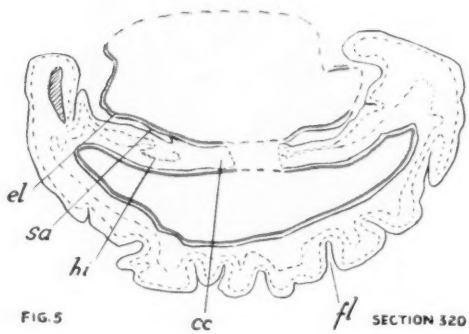
The keel-like longitudinal ridge of the ventricular floor mentioned in the gross description is seen here to correspond with the notching of the spurious fissura longitudinalis. A similar, less pronounced bulging on the right side corresponds to another sulcus.

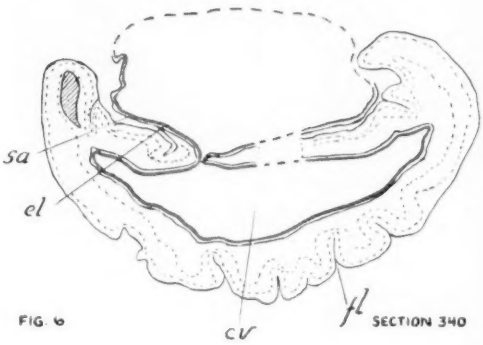
Section 900 (fig. 8) shows ventrally a well developed anterior commissure. Fibers of this commissure can already be detected in the proximity of section 800.

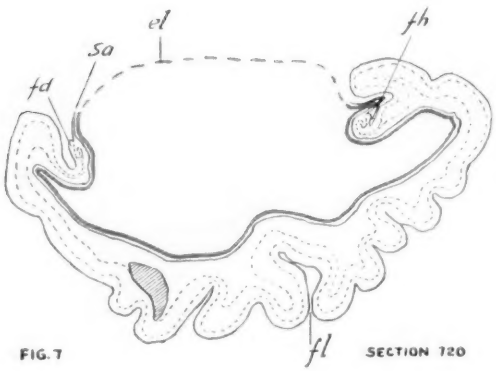
On the floor there are two slight elevations, each containing a large vein, venae terminales. These bulges are the rostral beginning of the thalami. To the right, under the ventricular floor and slightly lateral to the vena terminalis, a few irregular clusters of nerve cells are noted, which are probably the rostral part of the corpus striatum.

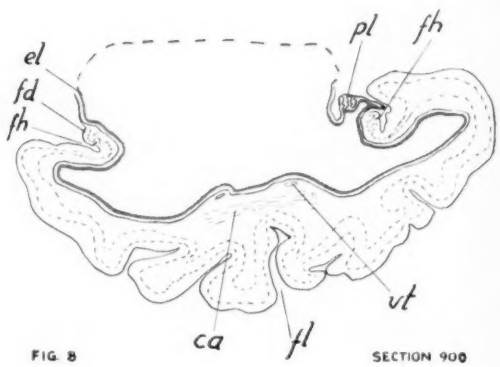












Figs. 3 to 14.—Outline drawings of transverse sections of the brain, showing the following structures: *aq*, aquaeductus Sylvii; *ca*, commissura anterior; *cc*, corpus callosum; *cg*, lateral geniculate body; *ci*, capsula interna, *cp*, colliculi superiores; *cs*, corpus striatum; *cv*, common ventricle of the end-brain; *el*, ependymal lining (the lost ependyma is indicated by the interrupted part of the line); *ep*, epiphysis; *fd*, fascia dentata; *fh*, fissura hippocampi; *fl*, fissura longitudinalis;

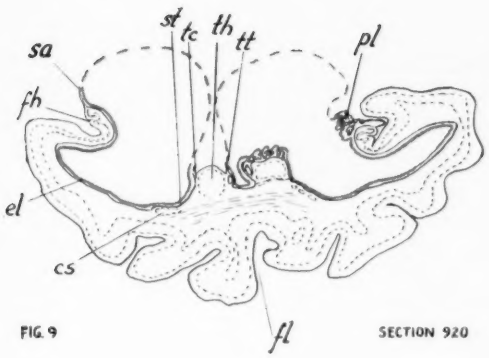


FIG. 9 SECTION 920

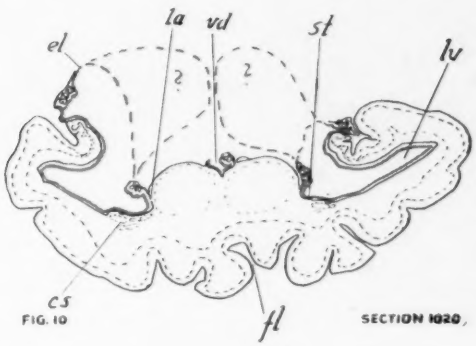


FIG. 10 SECTION 1020

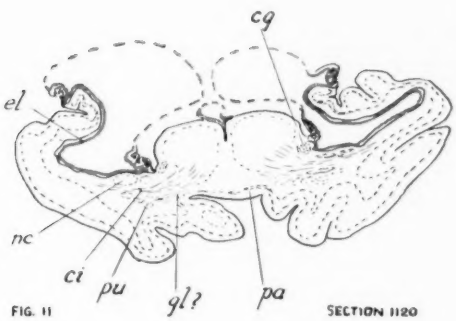


FIG. 11 SECTION 1120

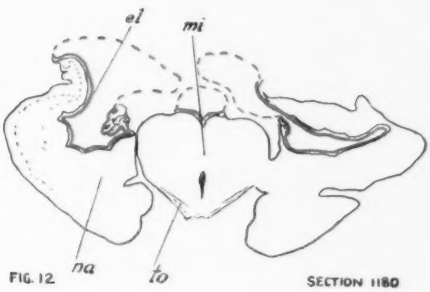


FIG. 12 SECTION 1180

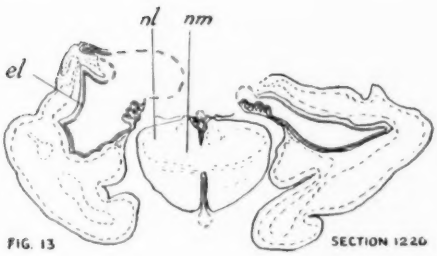


FIG. 13 SECTION 1220

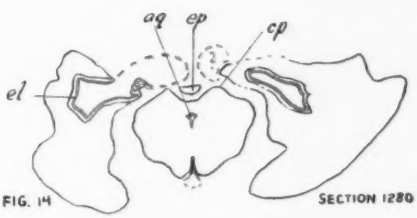


FIG. 14 SECTION 1280

gl (?), globus pallidus (?); *he*, hemorrhages; *hi*, hippocampal formation; *la*, lamina affixa; *lv*, lateral ventricle; *mi*, massa intermedia; *na*, nucleus amygdalae; *nc*, nucleus caudatus, *nl*, nucleus lateralis thalami; *nm*, nucleus medialis thalami; *pa*, substantia perforata anterior; *pl*, choroid plexus; *pu*, putamen; *sa*, wall of hydrocephalic sac; *st*, sulcus terminalis; *tc*, taenia choroidea; *th*, thalamus; *to*, optic tract; *tt*, taenia thalami; *vd*, ventriculus diencephali; *vt*, vena terminalis.

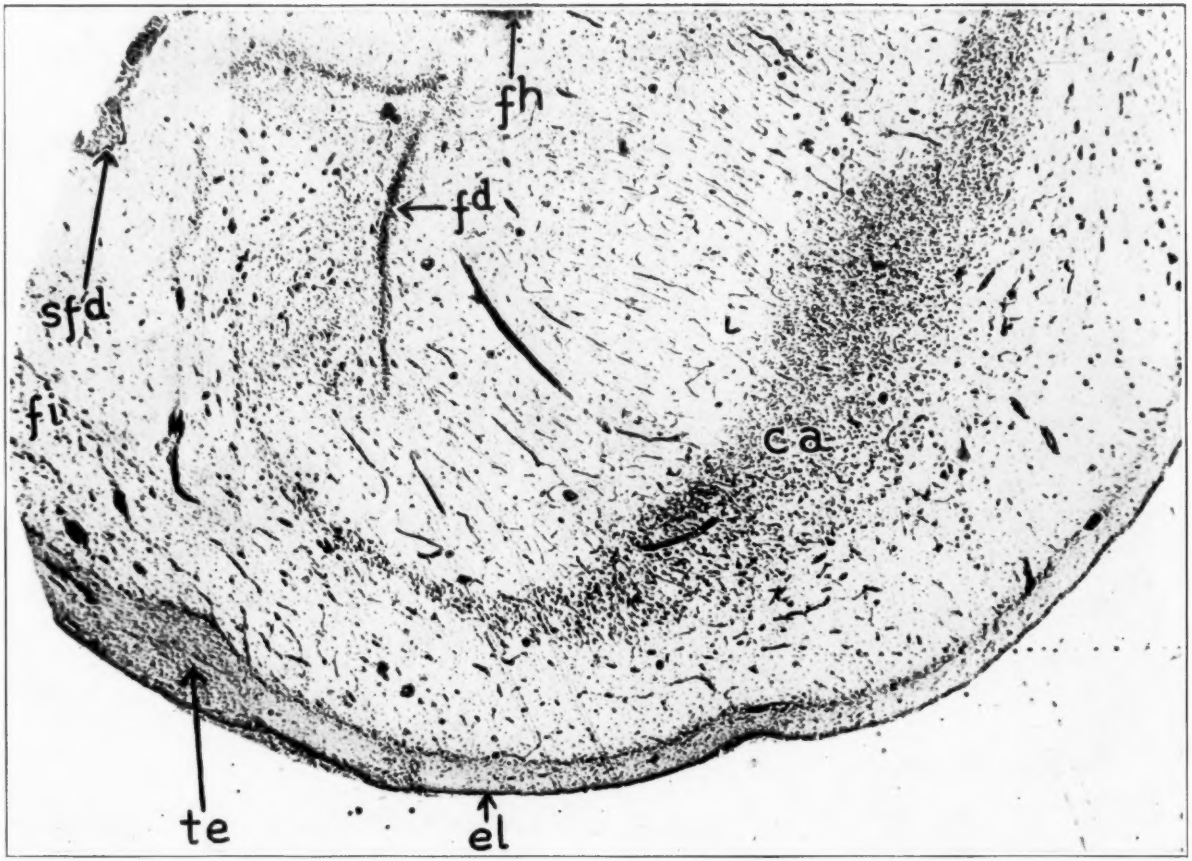


Fig. 15.—Photomicrograph of section 620, showing hippocampal formation. *ca*, cornu ammonis; *el*, columnar ependyma; *fd*, fascia dentata; *fh*, fissura hippocampi; *fi*, fimbria; *sfd*, sulcus fimbriodentatus; *te*, thickened subependymal glious layer.

Dorsally, on the right side, a typical choroid plexus which can already be seen on several of the more rostral sections, beginning around section 500, but without visible attachment, is attached to the fimbria fornicis.

Section 920 (fig. 9) shows the anterior commissure, the most rostral part of the thalamic nuclei and a rudimentary corpus striatum (nucleus caudatus). The thalamic nuclei are composed of large multipolar nerve cells heaped in a rather chaotic mass. It can only be presumed that they correspond to the group of the nuclei anteriores thalami. The rostral end of the third ventricle appears covered with distinct ventricular lining. The ependyma, well preserved in several parts, is columnar in type, in contrast to most of the lining of the end-brain ventricle, where the ependyma is flattened.

On the right side the third ventricle is continuous with the end-brain ventricle, its lining passing over a stretch of choroid formation covering the right thalamic swelling. On the left side the dorsal part of the thalamic swelling lacks ependymal lining and is apparently extraventricular (tuberculum anterius thalami?). The taenia thalami and taenia choroidea can be readily seen. Here the third ventricle and the left part of the end-brain ventricle are already separated.

Section 1020 (fig. 10) is in a plane immediately behind the caudal end of the anterior commissure. The thalami have assumed large proportions. Though it is still impossible to define clearly the boundaries of the thalamic nuclei, it seems, nevertheless, that the thalamic bulges represent mainly the medial and ventral nuclei. The third ventricle with its choroid plexus is readily recognized; so is also the end-brain ventricle, divided here into two lateral ventricles with double, dorsal and ventral choroid plexuses. As in normal brains, a portion of lining of the lateral ventricle, medial to the sulcus terminalis, is adherent to the lateral thalamic wall as lamina affixa.

In section 1120 (fig. 11) the fiber tracts running beween the white substance of the hemispheres and the thalamic nuclei are seen on both sides. These fiber tracts divide the irregular clusters of cells in the corpus striatum into two groups, a dorsal group slightly bulging into the lateral ventricle and representing an abortive nucleus caudatus and a ventral group, corresponding to the nucleus lentiformis, more correctly the putamen, as the ganglion cells of this group are entirely identical with those of the nucleus caudatus. The fiber tracts separating the two masses of cells constitute a meager capsula interna, consisting here almost entirely of the pedunculus superior thalami. Some fibers also join the putamen with the thalamic nuclei, accompanying the fibers of the capsula interna, and form a thin ansa lenticularis. Some large multipolar ganglion cells scattered among these fibers very likely belong to an abortive globus pallidus. The cells in question seem to be closely connected by transitional groups with hypothalamic cell formations. There is no typical claustrum, but it seems probable that some irregular rows of cells between the cortex and the cell clusters of the putamen constitute the vestige of a claustrum formation.

The ventral part of the lamina terminalis, below the protruding thalami and between the incompletely divided hemispheres, represents the substantia perforata anterior. Many small arteries can be seen entering the brain substance here, and the cortex represents a heterogenetic type (Brodmann) or allocortex of the simplest kind, consisting of only one layer (cortex primitivus). This layer is not uniform but shows groups or nests of cells (islets of Calleja), identifying this part with the rudimentary olfactory cortex of the anterior perforated space homologous to the tuberculum olfactorium of other mammals.

ependymal glious layer.

The lateral part of the thalamus, next to the lamina affixa, contains on both sides a small but absolutely typical lateral geniculate body with its alternating bands of cells and fiber layers (fig. 16). The position of the lateral geniculate body is for a human brain decidedly embryonal and resembles the position found in primitive animals, such as marsupials.

In section 1180 (fig. 12) the left hemisphere is already completely severed from the diencephalon, while on the right side the separation is nearly complete. In this part of the hemisphere, near the posterior pole (it cannot correctly be called occipital pole as there is no occipital lobe), the cortex is mostly hippocampal and parahippocampal formation. The medial part of the hemisphere contains an ill defined mass, partly cortical and partly related to the basal ganglia, which is not unlikely an irregularly developed nucleus amygdalae.

In the diencephalon another part of the third ventricle appears below the exceptionally large massa intermedia. At the diencephalic base a remnant of the optic chiasm and thin optic tracts can be recognized.

Section 1220 (fig. 13) shows the hemispheres and the diencephalon completely separated. In the thalamus the ventral, lateral and medial nuclei are well developed, the zona incerta is rather rudimentary and the hypothalamic centers are poorly differentiated; some of the nuclei tuberis, however, can be identified. The third ventricle below the massa intermedia is torn open ventrally, so that the connection of the infundibulum with the hypophysis is not traceable. About section 1250 a normal epithalamus with distinctly differentiated ganglion habenulae appears. In the following caudal sections the posterior commissure and the pineal body are present.

Section 1280 (fig. 14) shows the most caudal parts of the hemispheres, the anterior colliculi of the mesencephalon and the caudal part of the epiphysis. The aqueduct is of normal shape; the nuclear configuration of the mesencephalon shows no irregularity. The cerebral peduncles, however, are much reduced, as there seem to be no pyramidal tracts. The corticopontile tracts are also defective. At the base of the mesencephalon parts of the mamillary bodies and the damaged mamillary recess can be detected.

The more caudal sections show practically normal conditions as far as the cerebral nerves and most of the nuclei of the brain stem are concerned. The nuclei pontis, the superior olivary nucleus, the cerebellar nuclei, the inferior olive, the nuclei of Goll and Burdach and the spinal trigeminal tract and its nucleus have an almost normal appearance.

The main defective features in the brain stem are the almost complete lack of corticopontile tracts and the abscence of pyramidal tracts. Accordingly there is no decussatio pyramidum. It cannot be decided whether a few fibers running in the position of the normal pyramidal tracts are to be considered as rudiments of this system or are merely fibers of other origin passing through the space left by the pyramidal system.

B. Cyto-Architecture.—The cortex cerebri has retained a definite stratification corresponding to the fundamental six-layered pattern with irregular regional differences. The cyto-architectural picture cannot, however, be regarded as normal (fig. 17). The molecular layer is everywhere rather wide. The external granular layer is pronounced but shows in most places an irregular, wavy outline which is decidedly abnormal and can be found in normal brains only in a few regions of the allocortex.

The pyramidal layer is wide and is divided in a sparse outer sublayer without developed pyramidal cells and a dense inner sublayer with irregularly scattered medium and large pyramidal cells near its inner border.

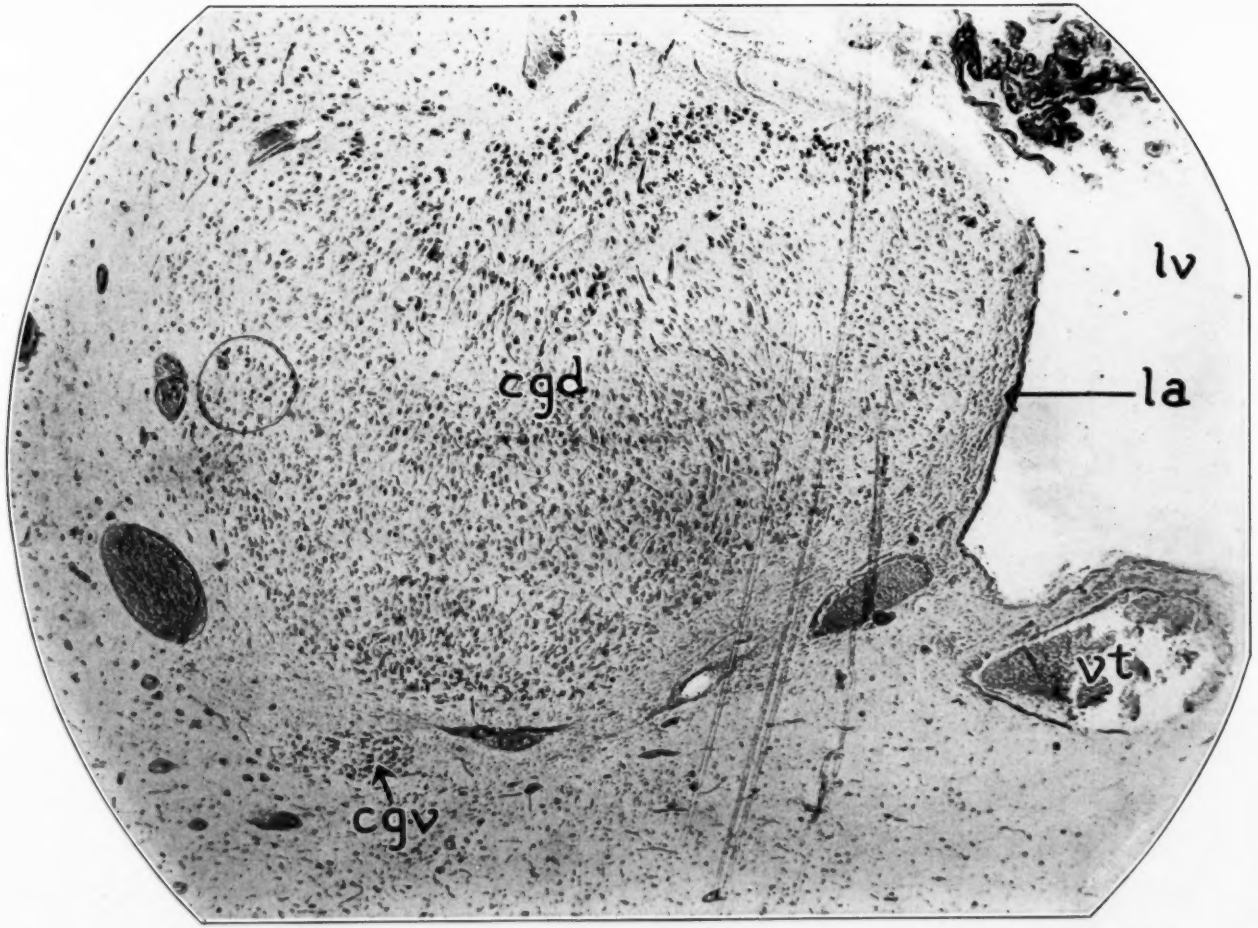


Fig. 16—Photomicrograph of section 1120, showing the lateral geniculate body. *cgd*, dorsal nucleus of the lateral geniculate body; *cgv*, ventral nucleus of the lateral geniculate body; *la*, lamina affixa; *lv*, lateral ventricle; *vt*, vena terminalis.

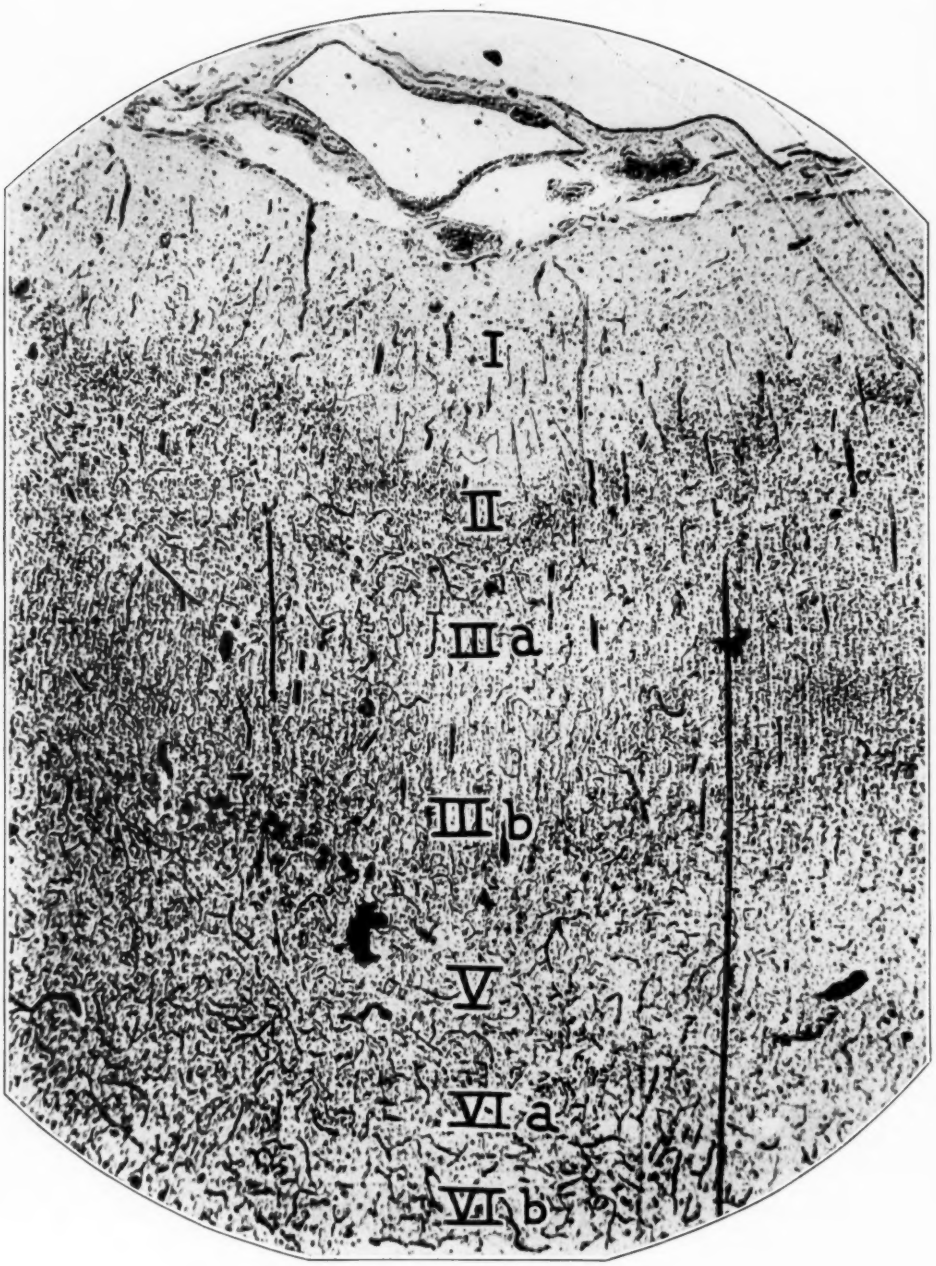


Fig. 17.—Photomicrograph of section 620, showing typical lamellation of the cerebral cortex.

The granular layer is completely absent. Only here and there a greater number of small elements resembling granular cells crowd in within the limits of the inner part of the pyramidal layer; if this is to be interpreted as a rudimentary fourth layer, it can hardly be separated from the third layer.

The ganglionic layer is rather narrow and sparse and shows no large pyramidal cells.

The multiform layer is narrow, although somewhat wider than the fifth layer; an outer dense and an inner sparse sublayer are noticeable.

The regional differences cannot be compared with the cyto-architectural differentiation in normal regions or areas but consists of alternating stretches of poorly differentiated stratification where the general pattern described is less pronounced. As in normal brains, the cortex is wider in the gyri and narrower in the depth of the sulci.

Toward the dorsomedial border, near the hippocampal formation, the cortex assumes some of the characteristics of the parahippocampal cortex, consisting in lesser differentiation of the second and third layers, which tend to merge into one wide unit, and a corresponding tendency of the fifth and sixth layers.

In the anterior perforated space, as has already been mentioned, an allocortex of basal olfactory type is present.

Nowhere can be discovered any formation resembling the most conspicuous normal cyto-architectural areas, such as the gigantopyramidal, postcentral or striate area.

The individual cells are more or less neuroblast-like, i. e., the cell body is very small in relation to the nucleus; in most cortical cells there is little, if any, Nissl substance. Only the few large pyramids of the third layer show tigroid substance but without the normal pattern; the tigroid is more diffuse, showing no distinct striped pattern or clustered in dark, shrunken lumps.

COMMENT

The brain described belongs unquestionably to the group of malformed brains collectively named arhinencephalic, closely related to the malformed brains showing cyclopia, and first classified in 1882 by Kundrat.[2]

The most salient features in such brains are: hydrocephalus with a protruding membranous hydrocephalic sac, an end-brain incompletely divided in hemispheres, an exposed cerebellum, absence of olfactory bulbs and tracts and often a nearly normal brain stem.

In typical cyclopia the added features are the well known defects of the eyes and optic tracts, besides the absence of olfactory bulbs. In rare cases of cyclopia an unpaired rudimentary olfactory bulb with tract can be found in the median line.

While various intermediary forms connect cyclopic and arhinencephalic brains, the brain here described is a typical arhinencephalic form.

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2. Kundrat, H.: Arhinencephalie als typische Art von Missbildung, Wien. med. Bl. **5**:1395, 1882; cited by Ernst.[5]

Schwalbe and Josephy [3] have divided arhinencephalic brains into two groups. In the first they classify brains with an unpaired end-brain, belonging more probably to the group of cyclopic brains; in the second, normal or nearly normal brains (including the end-brain) characterized by absence of olfactory bulbs and tracts.

It is clear that the brain here described belongs to the first group. From a detailed description and analysis it is apparent that the brain showed many peculiarities differing widely from the arhinencephalic brain described in 1926 by Goldstein and Riese [4] and that this report adds much to the descriptions of similar brains given by older authors of the nineteenth century.

Goldstein and Riese described the brain of a child, aged 4 years, which showed in many respects a higher degree of development than did the brain which we describe. While the hemispheres were incompletely divided and a caudal hydrocephalic sac was present, the walls of the end-brain showed a nearly complete degree of inversion, so that the greater part of the roof of the end-brain was formed by pallium. The corpus striatum, including the nucleus caudatus, putamen, globus pallidus, claustrum and nucleus amygdalae and also the thalamic nuclei were, in the opinion of the authors, relatively overdeveloped. The ganglia of the brain stem, the nucleus ruber, the nuclei of the cerebellum and their connections, the brachia conjunctiva and the restiform body were also developed beyond the normal size.

On the other hand, in Goldstein and Riese's patient, who was 4 years of age, the cerebral cortex was as poorly developed as in our patient, a new-born infant.

Goldstein and Riese considered their case important in that it demonstrated a special development of subcortical automatic sensorimotor functions released from the cortical influence.

Riese had already described another case of arhinencephalic brain in a new-born infant in which there were an unpaired ventricle and a poorly developed end-brain, the sulci and gyri being absent, closely corresponding to the cases in older patients reviewed by Ernst [5] and Schwalbe (1913).

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3. Schwalbe, E., and Josephy, H.: Die Cyclopie, in Schwalbe, E.: Morphologie der Missbildungen des Menschen und der Tiere, Jena, Gustav Fischer, 1913, pt. 3, sect. 1.

4. Goldstein, K., and Riese, W.: Klinische und anatomische Beobachtungen an einem vierjährigen riechhirnlosen Kinde, J. f. Psychol. u. Neurol. **32**:291, 1925-1926.

5. Ernst, P.: Missbildungen des Nervensystems, in Schwalbe, E.: Morphologie der Missbildungen des Menschen und der Tiere, Jena, Gustav Fischer, 1909, pt. 2, sect. 2.

The peculiarity in our case is the high degree of eversion of the dorsal wall of the end-brain, which simulates conditions in lower vertebrates. Figure 18 demonstrates the transition from moderate inversion to extreme eversion in Anamnia and can be compared with figures 5 and 6.

The most extreme eversion occurs in teleosts; a lesser degree of eversion is present in ganoids, and a still less marked eversion—a middle position between inversion and eversion—in dipnoids and in some selachians (Holocephali); a decided but moderate inversion is present in amphibians and in most selachians. In dipnoids the eversion is limited to the part of the end-brain developed within the lamina terminalis; the more rostral parts are completely inverted and developed as paired hemispheres.

Though in our case only a slight eversion was present, it was nevertheless extreme for a human brain when compared with the conditions

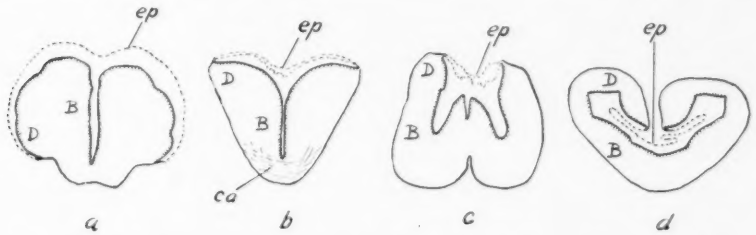

Fig. 18.—Eversion and inversion of the wall of the end-brain in Anamnia demonstrated by cross-sections through corresponding parts of the end-brain of lower vertebrates: *a*, teleost (Carassius auratus); *b*, ganoid (Acipenser sturio); *c*, dipnoid (Protopterus annectens); *d*, amphibian (Triton cristatus). *B*, basal part of the end-brain; D, dorsal parts of the end-brain (pallium sensu stricto); *ep*, epithelial wall of the brain; *ca*, anterior commissure.

Figures simplified: *a*, *c* and *d*, from Kuhlenbeck (Die Grundbestandteile des Endhirns im Lichte der Bauplanlehre, Anat. Anz. **67**:1, 1929); *b*, from Johnson (The Nervous System of Vertebrates, Philadelphia, P. Blakiston's Son & Co., 1906).

found in the lamina terminalis of dipnoids rather than with those in amphibians, which seem to be more similar only at a first glance.

In our case there was also a much higher relative development of the cortex than of the corpus striatum, which was rudimentary and hardly recognizable by the naked eye. Furthermore, there were a rudiment of corpus callosum and a well developed anterior commissure, which were wanting in the case reported by Goldstein and Riese. The thalamic nuclei were subnormal, especially the lateral geniculate body, and also the optic tracts; these features are common with those of the cyclopia. The brain stem was nearly normal but it certainly was not overdeveloped as in the case reported by Goldstein and Riese.

The complete or almost complete absence of the fourth (internal granular layer) seems to corroborate recent views on the special significance of the granular layers for the development of the normal cerebral cortex, at least as far as the fourth layer is concerned. Loo [6] came to the conclusion that both granular layers gave cells to other layers, and he suggested a "creative function" of the second and fourth layers.

It is noteworthy that in our case of arhinencephalic brain some cortical formations recognized as secondary and tertiary olfactory centers were comparatively well developed, such as the cortex of the anterior perforated space and the hippocampal formation. A similar observation had already been made by Ranke [7] and interpreted by him as a proof that the cortical differentiation is to a high degree independent from the differentiation of corresponding peripheral centers. Furthermore, in our case the ganglia habenulae and the mamillary bodies were found to be in a rather normal state of development. It must, therefore, be added from the analysis of this case that not only cortical olfactory centers but also diencephalic nuclei, commonly regarded as at least partly olfactory and connected with secondary and tertiary olfactory centers of the end-brain, can differentiate independently of the primary olfactory centers.

The genesis of this malformation can be conceived as an arrest or retardation in a certain early stage of development of the end-brain. During the first stage of formation of the end-brain in all vertebrates a telencephalon medium or pars impar telencephali is evolved, the base of which is provided by a protruding section of the lamina terminalis dorsal and rostral to the site of the later appearing anterior commissure. In the next stage the paired hemispheres are evolved, beginning with the paired bulbi olfactorii. Two groups of vertebrates differ widely in the extent of this second formative process. In the first group, including teleosts, ganoids, selachians, dipnoids and amphibians, the pars impar telencephali remains relatively large. It is most extensive in teleosts and ganoids, in which only the olfactory bulbs are separately evaginated while the rest of the end-brain remains a telencephalon impar. In the other forms a greater part of the end-brain is evaginated as paired hemispheres, while the telencephalon medium is correspondingly reduced.

In the second group, including cyclostomes, reptiles, birds and mammals, the telencephalon medium becomes nearly completely reduced dur-

6. Loo, Y. T.: Formation of Human Cerebral Cortex: An Ontogenetic Study with a Discussion on the Function of Different Cortical Layers, Anat. Anz. **68:** 305, 1929.

7. Ranke, O.: Zytoarchitektonik der Grosshirnrinde in einem Falle von Cyclopie, Autoreferat, Neurol. Centralbl. **32:**880, 1913; cited by Schwalbe and Josephy.[3]

ing the ontogenetic development, as the evagination of the paired hemispheres includes or draws in the whole substance of the transitory telencephalon medium. In adults only a small intimation of the telencephalon medium remains between the paired foramina of Monro and above the projecting part of the commissura anterior in the lamina terminalis.

In our case the formative process of the telencephalon had been inhibited at the end of the first stage, about the sixth week of intrauterine development, so that only an exceedingly small part of the telencephalon had become paired. The growth and structural differentiation of the telencephalon, nevertheless, continued although impaired, resulting in structures of the end-brain almost exclusively developed within the greatly enlarged and rostrally protruded telencephalic section of the lamina terminalis and therefore showing general morphologic features strikingly similar to the brains of some fishes. The structural features of the cortex and the basal ganglia which seemed to develop to some degree independently of the factors modeling the gross form pattern were, however, quite human, regardless of their defective development.

This parallelism with a pattern common to very low species of vertebrates is combined with a condition found in lower mammals (marsupials, edentates, chiropters): the arrested development of the corpus callosum, resulting in an abortive structure, caused the development of a typical supracommissural hippocampal formation.

The inhibition of the paired end-brain formation explains somewhat the lack of olfactory bulbs and tracts, these parts being one of the most important components of the early hemisphere anlage.

If a disturbance of the early formative phase occurs at a stage when the primary prosencephalon is not yet differentiated into the telencephalon and the diencephalon and while the optic vesicles are in process of formation, cyclopia results, as has been pointed out by Schwalbe and Josephy. It is clear that such disturbances would also involve the subsequent formation of the end-brain and result in the typical combination of cyclopia with arhinencephalia.

On the other hand, it has been suggested by Ariëns Kappers [8] that the outgrowth of the paired vesicles of the end-brain (which follow the outgrowing paired olfactory bulbs) is due to the neurobiotactic influence of the paired olfactory placodes and that, therefore, in cases of arhinencephaly, in which these placodes fail to exert that influence, the anterior parts of the end-brain remain unpaired.

8. Ariëns Kappers, C. U.: The Evolution of the Nervous System in Invertebrates, Vertebrates and Man, New York, Van Riemsdyck Book Service, 1929, p. 96.

Unfortunately, in the cases analyzed in the literature which has been available to us no attempt has been made to examine the nasal mucous membrane with adequate histologic methods to demonstrate conclusively the lack of an olfactory epithelium. Also in our case the nasal mucous membrane was not preserved for histologic examination. But even if the olfactory epithelium were found lacking it could not be stated whether a normal olfactory placode was present or not during the early ontogenetic stages, as the want of an olfactory epithelium could be a secondary feature (atrophy) due to the failure of a functional connection of the developing placode with the central nervous system.

It must be stated further that in teleosts and ganoids, as already mentioned, the end-brain proper remains unpaired nothwithstanding the development of paired olfactory bulbs and tracts.

There have also been recorded cases of complete lack of olfactory tracts and bulbs in human brains which were otherwise normal, with fully developed cerebral hemispheres (Issajew [9]).

If the genesis of arhinencephaly were merely due to a failure of the placodes to influence the pairing of the vesicles, the lack of development of olfactory bulbs and tracts could be made plausible, but it would be difficult to explain why this defect should be sometimes associated with normally developed hemispheres and sometimes with a highly deficient unpaired end-brain.

Moreover the hypothesis of failure of the placodes does not account for the frequent combination of arhinencephaly and cyclopia.

It is difficult to offer an explanation for the inhibition of formative development, as the hydrocephalus which could be viewed as the cause might be secondary. It must be especially considered that the brain stem has developed in a normal way and that the ventricular system shows a clear and free passage from the enlarged end-brain ventricle to the nearly normal third ventricle, which had probably only a slightly dilated epithelial and choroid roof and continued caudally to an absolutely normal aqueduct and fourth ventricle. Malformations like arhinencephaly and cyclopia may be due to intrinsic influences going back as far as the fertilized egg or the first formation of the medullary fold and cannot yet be analyzed in terms of the present knowledge of these processes.

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9. Issajew, P. O.: Ein Fall der Abwesenheit des N. olfactorius, Anat. Anz. **74**:398, 1932.

SUBDURAL TRACTION AND POSTTRAUMATIC HEADACHE

STUDY OF PATHOLOGY AND THERAPEUSIS

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MONTREAL, CANADA

One of the most frequent sequelae to injury of the head is posttraumatic headache. Sufferers from this complaint all too often wander from doctor to doctor, from clinic to clinic and, alas! from lawyer to lawyer under the unjust suspicion of being neurotic or malingering. Posttraumatic headache associated with dizziness forms a clinical entity which is described by these patients in altogether typical fashion. The patient's description of his symptoms makes the diagnosis certain and allows the understanding physician to recognize the true sufferer and to distinguish him from the neurotic patient and the malingerer.

In 1927 this condition was described as a disease entity by one of us (W. P.).[1] The fact that the procedure of treatment resulted in relief of symptoms in each of the reported cases was the final proof that the syndrome was a true one and that the underlying pathologic change, whatever it might be, was common to each member of the group.

In the past eight years additional cases have been recorded in the literature. In 1929 Boyd[2] reported ten cases of posttraumatic headache, in seven of which treatment with properly planned spinal insufflation of air resulted in relief of symptoms. He concluded that the method constitutes a "specific treatment for bona fide posttraumatic headache." Skinner[3] in 1930 reported a case in which cure was effected,

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The words "pathologic" and "anatomic" are used in this article only in order to conform to the terminology which is compulsory for publication in the ARCHIVES OF NEUROLOGY AND PSYCHIATRY. The authors would prefer to use the words "pathological" and "anatomical."

1. Penfield, W.: Chronic Meningeal (Post-Traumatic) Headache and Its Specific Treatment by Lumbar Air Insufflation, Surg., Gynec. & Obst. **45**:747, 1927.

2. Boyd, Douglas: Post-Traumatic Headache Treated by Spinal Insufflation of Air, Arch. Surg. **18**:1626 (April) 1929.

3. Skinner, H.: Headache (Post-Traumatic) Relieved by Lumbar Air Insufflation, Am. J. Surg. **8**:842, 1930.

and Reichert [4] added six cases, with four complete cures following the use of small amounts of air. Monrad-Krohn [5] also reported successes and failures and stated that there must be an underlying cause involving the meninges. Jessen [6] obtained relief in four of ten cases of "traumatic headache" with insufflation of air and concluded that an abnormality in the circulation of the cerebrospinal fluid was present and that "cysts upon the surface of the brain" could be shown. Lewy [7] discussed the relief which may be afforded patients suffering from headache due to adhesion as the result of meningitis serosa adhaesiva circumscripta, and he vaguely grouped together the cases in which the condition is produced by trauma or by inflammation.

ANATOMIC BASIS OF PAIN IN THE HEAD

We shall turn aside briefly from the condition of posttraumatic headache to a consideration of the anatomic basis of intracranial pain. Within the cranial cavity most structures are entirely insensitive and incapable of producing pain, however, they may be stimulated. The neurosurgeon who opens the cranial cavity without general anesthesia needs only to anesthetize the scalp. He removes the bone without producing sensation. The dura mater may be cut without pain, except in certain areas, and the pia mater and brain may usually be handled without causing discomfort.

In order eventually to be able to analyze the areas sensitive to pain we have long recorded in our clinic the observations of intelligent patients during operation with local anesthesia in respect to the following questions: what intracranial structures were sensitive; how they might be stimulated; where the pain was felt, and what its character might be. Such observations had to be made, of course, with merciful forbearance and as opportunity was presented in the course of many types of operation.

The following conclusions are based on the study of thirty-three selected cases, which are reported in detail elsewhere.[8] The observations, however, may be summarized briefly as follows: The dural sinuses are sensitive to pressure, traction, heat and electrical stimulation. The

4. Reichert, F.: Specific Treatment of Post-Traumatic Localized Headache by Subarachnoid Pneumotherapy, S. Clin. North America **11**:1123, 1931.

5. Monrad-Krohn, G. H.: Experiences with Endolumbar Inflation of Air in Traumatic Headache, Acta psychiat. et neurol. **6**:395, 1931.

6. Jessen, H.: Treatment of Traumatic Headache by Insufflation of Air, Acta psychiat. et neurol. **8**:71, 1933.

7. Lewy, F.: Der Adhäsionskopfschmerz als Folge der Meningitis serosa adhaesiva circumscripta, Ztschr. f. klin. Med. **116**:36, 1931.

8. Penfield, W.: A Contribution to the Mechanism of Intracranial Pain, A. Research Nerv. & Ment. Dis., Proc. **15**:399, 1934.

middle meningeal artery and its larger dural branches are also usually sensitive. Cerebral vessels are insensitive, except occasionally for a tributary vein just before it enters a dural sinus or a vessel low in the fissure of Sylvius. The skull, the dura itself and the brain are quite insensitive to cutting or electrical stimulation.[9] The only type of sensation which can be produced from within the cranial cavity is interpreted by the subject as pain or pressure. He usually calls it headache, sharp pain or pressing pain.

Pain due to stimulation of the meningeal arteries is well localized by the patient to the region stimulated and is often sharp. Pain derived from the dural sinuses is usually referred to a point some distance from the site of stimulation. From the straight and transverse sinuses the pain is referred forward toward the ipsilateral eye (fig. 1). From the

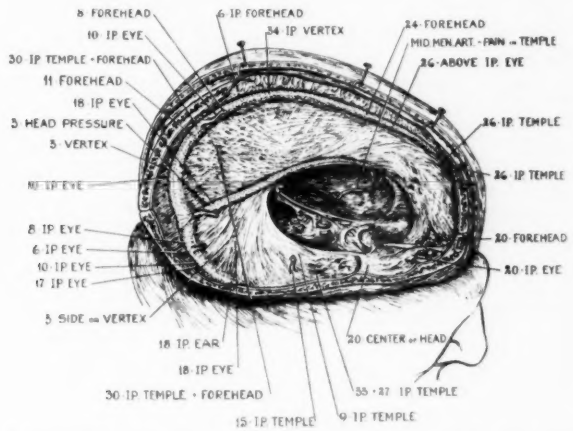

Fig. 1.—Schematic drawing indicating the areas to which the intracranial pain is referred (from a previous article by one of us [W. P.][8]). The lines denote the points of stimulation, the legends the areas in which pain is felt and the numerals the case numbers in the original series. *Ip* stands for "ipsilateral."

superior longitudinal sinus the ache is referred to the frontal region, where it sometimes is present in the midline but more often is lateralized to the side on which the pressure is made. From the longitudinal sinus pain may in some cases be referred to the temple, especially when the point of stimulation of the sinus is more anterior, or it may occasionally be referred to the top of the head.

In procedures on one side of the cranial cavity only the lateral part of the wall of the longitudinal and straight sinuses on one side and the

9. An exception to this statement must be admitted. Electrical stimulation low in the temporal or the frontal lobe sometimes gives pain which is referred to the same side of the head. This is especially true near the fissure of Sylvius.

superior portion of the wall of the transverse sinus may be touched. This explains the ipsilateral reference of the pain. Traction on the veins which anchor the brain to the sinuses gives rise to pain typical of stimulation of the sinus in question. Very few observations were made on the posterior fossa, as local anesthesia was rarely used in operations in this region. The fact that expanding lesions in this fossa usually give rise to headache which radiates from the occipital region down the back of the neck leads one to speculate that pressure on the ventral portion of the wall of the transverse and straight sinuses causes pain to be referred downward.

Finally, it is reasonable to predicate that when the cause of headache is intracranial, the pain must arise directly or indirectly in one of the sensitive intracranial areas just described.

PATHOLOGIC BASIS OF POSTTRAUMATIC HEADACHE

Physical examination of patients with this condition reveals nothing which can be called typical. There are characteristic findings, however, in encephalograms taken after spinal insufflation of air. The abnormality thus disclosed involves not the ventricles and apparently not even the subarachnoid spaces but the subdural space. The subdural space normally contains fluid of its own which differs from the cerebrospinal fluid.[10]

Insufflation of air, if used in treatment, should be carried out in such a way as to keep the gas out of the ventricles and place it in the subarachnoid and subdural spaces over the hemispheres.[11] In a typical case roentgenograms taken immediately after the insufflation may show a relatively normal subarachnoid space. Plates taken on the next day usually show that the air has collected in the subdural space, often in large amount. The roentgen exposures shown in figure 2 were made when the brow was uppermost. Air is shown in the subarachnoid fissures in *A*, while a plate taken on the next day, with the head in the same position, shows the air to be in the subdural space (fig. 2 *B*). A small amount of air found its way into the ventricle on the second day, owing to the fact that the patient did not maintain a proper posture. The air may remain in the subdural space in large amount for a considerable time, moving with each movement of the head. In figure 3 *A* the air appears to be well distributed in the subarachnoid space after

10. Penfield, W.: (*a*) Subdural Effusion and Internal Hydrocephalus, Am. J. Dis. Child. **26**:383 (Oct.) 1923; (*b*) The Cranial Subdural Space, Anat. Rec. **28**:173, 1924.

11. In spite of the description in the original report, failure to utilize a technic necessary to keep the air out of the ventricles explains the negative results obtained with the method in some clinics.

insufflation, while in figure 3 *B*, taken four days later, it is shown to be still present, but in the subdural space.

At times the air is trapped in small pockets on the second day. These pockets seem to be in the subdural space also, as the initial circulation appears to be free. For example, in figure 4 *A* the subarachnoid space is shown to be wide open, whereas on the next day it is evident

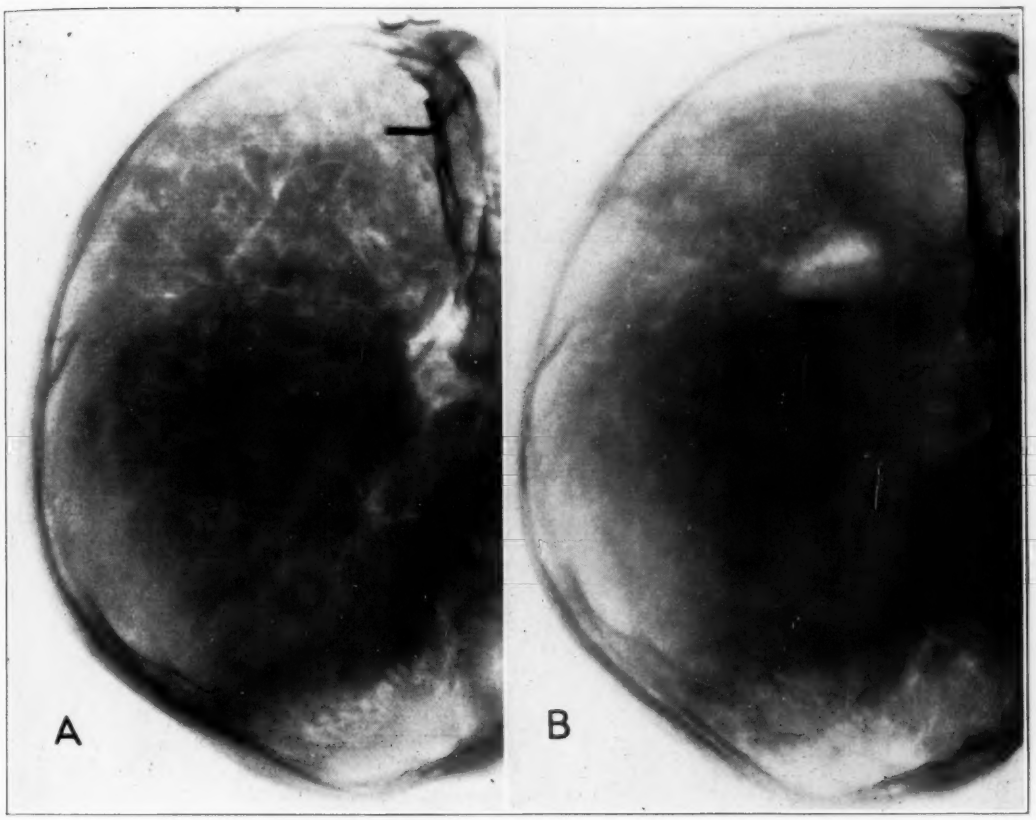

Fig. 2.—Encephalograms taken in a case of posttraumatic meningeal headache in which complete relief was obtained with spinal insufflation of air. In *A*, taken immediately after the insufflation, with the brow up, air is shown in the subarachnoid spaces, and in *B*, taken twenty-four hours later, with the head in the same position, in the subdural space.

that the subarachnoid pattern has disappeared, to be replaced by a spotty distribution of air beneath the uppermost portion of the skull (fig. 4 *B*). This spotty arrangement suggests incomplete opening of the space, although relief sometimes occurs even in these cases.

REPORT OF CLINICAL CASES IN WHICH TREATMENT WITH CRANIAL INSUFFLATION WAS CARRIED OUT

Further evidence as to the nature and situation of the lesion in posttraumatic headache has been obtained in cases in which the subdural space was inspected directly as follows: One or more trephine holes were made according to the indications in the case, usually as near as possible to the site of the habitual pain.

CASE 1.—A man was struck on the top of the head by a brick, which fell ten floors. Following the accident, headache had been present ten months. After the induction of nupercaine analgesia the skull was trephined at the site of the maximum headache. The dura was incised and a curved dissector passed into

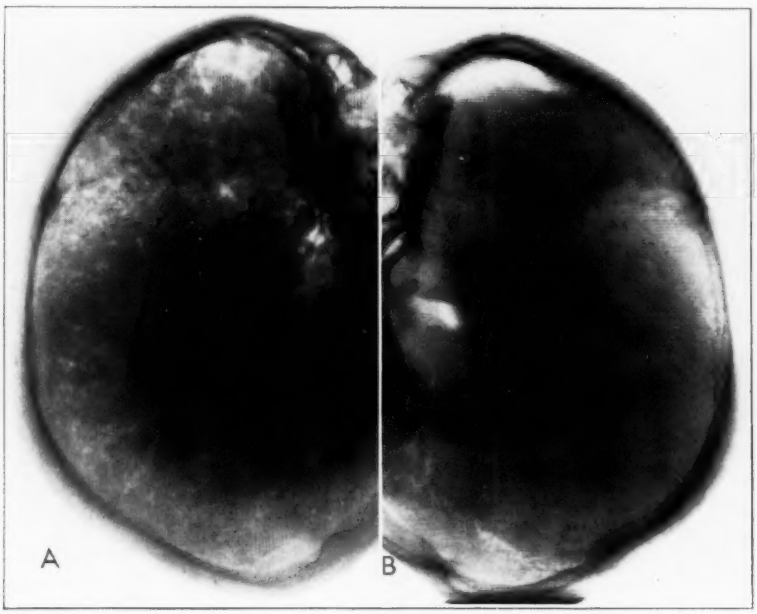

Fig. 3.—Encephalograms taken in a case of posttraumatic meningeal headache in which the ache was completely relieved with the use of spinal insufflation but the periodic dizziness persisted. In *A*, taken immediately after insufflation, air is shown in the subarachnoid spaces, and in *B*, taken four days later, in the subdural space.

the subdural space. Pressure downward on the pia-arachnoid produced no sensation. Pressure upward on the under-surface of the dura was without sensation, except at a point directly under the old scar in the scalp. Pressure on this point caused the patient to cry out with pain. The first time the area was approached, resistance was felt, as though adhesion had been encountered. The pain could be reproduced at will by returning the dissector to this point. The patient stated that the pain resembled in situation and quality the pain in the head from which he suffered chronically. It seems probable that the point in question

corresponded with a dural artery. The patient was improved but not cured, and he claimed a large compensation.

Case 2.—The cause of this man's headache was a blow in the parietal region. A thickened area of scalp recorded the site of the blow, and the habitual headache occurred in this region. An incision was made in the thickened scalp, with local analgesia, and a piece of bone, about 1.5 cm. in diameter, was removed with the bur. Some vessels within the bone proved to be sensitive, and the pain was referred accurately by the patient to the site of the operation. The dura was opened. A small amount of fluid was present in the subdural space. A small artery was

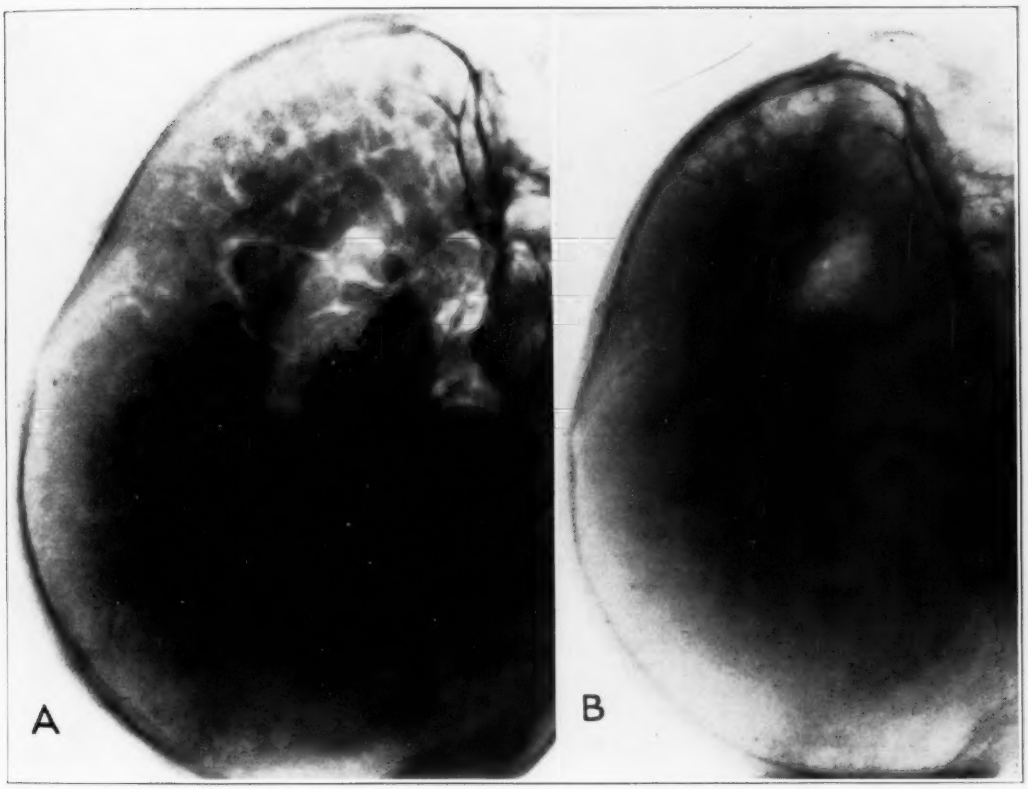

Fig. 4.—Encephalograms taken in a case of posttraumatic headache in which complete relief was obtained with spinal insufflation. In *A*, taken immediately after insufflation, air is shown in the subarachnoid spaces, and in *B*, taken twenty-four hours later, spotty distribution of air in the subdural space is indicated.

seen in the dura at the edge of the opening, and this was sensitive to pressure. The curved instrument was inserted into the subdural space. It encountered adhesions which were definite but easily broken. Pressure on the brain produced no sensation. Pressure upward on the under-surface of the dura anterior to the opening produced no sensation. Posteriorly, however, pressure produced pain, which the patient stated was not identical with the habitual headache but similar to it.

A lumbar puncture was performed by an assistant. After only 5 cc. of air had been injected into the lumbar space, air appeared in the subarachnoid fissure beneath the opening. Obviously there was no impediment to the local circulation of cerebrospinal fluid. When spinal fluid was allowed to drain from the lumbar puncture needle, the brain fell away from the opening. Spinal fluid was then reinjected, causing the brain to expand again until it pressed against the skull, as seen through the opening. When this occurred, the patient complained immediately of local headache. The spinal fluid was again drained off by the lumbar route; the scalp was closed, and 20 cc. of air was injected beneath the scalp into the subdural space.

The patient's condition is greatly improved at the time of writing, but he cannot be called completely cured. He is able to work.

Fig. 5 (case 3).—Encephalogram taken with an anteroposterior exposure in a case of severe posttraumatic headache. No relief was obtained with spinal insufflation. Air is shown to be well distributed in the subarachnoid spaces.

Case 3.—A man struck his head on an iron rail in April 1933. Headache began three months later and was associated with mental changes. Two spinal insufflations were carried out, with no relief. The subarachnoid spaces filled well (fig. 5). No evidence of escape of air into the subdural space was manifested, although roentgenograms were not taken on the second day.

Bilateral trepanation was performed in May 1934. The dura was opened carefully without injuring the arachnoidea; no subdural fluid could be discovered. On the left side there were numerous adhesions between the dura and the arachnoidea. Separation of these adhesions with a curved instrument produced pain only at two points, and this pain the patient likened to the pain he had habitually on coughing or sneezing. The arachnoid was thick, and incision was necessary before cerebrospinal fluid appeared; it then flowed freely.

On the right side, beneath the dura, was a thin reddish membrane not over 0.5 mm. in thickness. The arachnoidea in this region also was thick. A piece was excised without damage to the pia mater. Fluid came freely. The adhesions were less marked on this side than on the other. An instrument was passed for a considerable distance from the hole. Lumbar puncture was carried out, and the brain fell away from the skull as the fluid drained out. Specimens were removed for examination, as will be described.

Roentgenograms were made, and it was seen that air was present in the subdural space, but only in circumscribed areas over each hemisphere (fig. 6). The subdural space was closed too effectively to be opened by the air with oscillations of the head. Only the dissecting instrument was capable of removing the adhesions as far as it could reach.

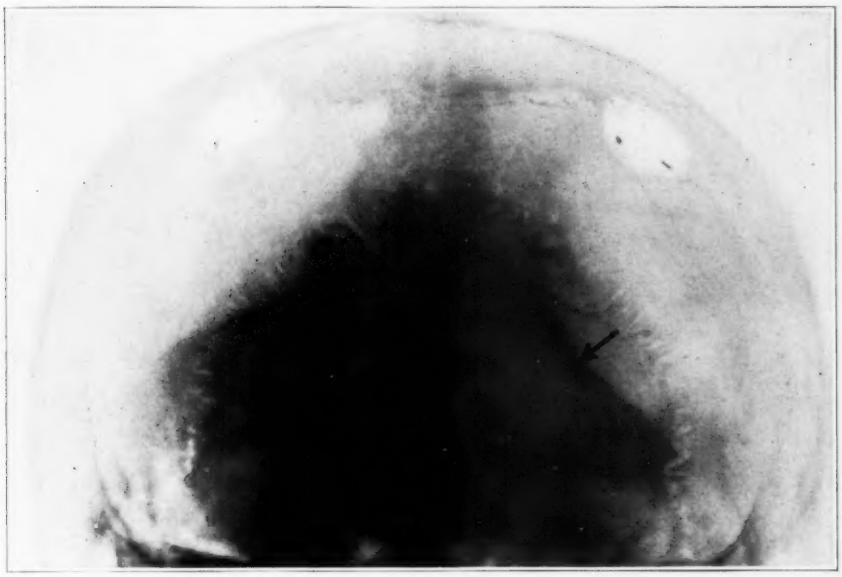

Fig. 6 (case 3).—Encephalogram showing separation, by means of an instrument, of the arachnoid and dura near the trephine holes. Air was seen only in the portion of the space thus opened, as indicated by the arrow.

The condition of the patient was improved by this procedure, although he had not been helped by spinal insufflation. He was not cured, however, and observed for a time after operation that the principal pain was at a distance from the areas of trepanation.

The dura and arachnoidea removed through the trepanation openings were examined histologically. The dura was somewhat thickened. Red blood cells in layers divided by a meshwork of connective tissue were observed on the outer surface, i. e., on the side adjacent to the bone. Attached to the under-surface of the dura was a partly organized sponge of red cells containing pigment-laden phagocytes (fig. 7). The arachnoid contained red cells in a loose net, with numerous compound granular corpuscles. On the outer surface was a partially organized thin layer of red cells. Obviously, these two membranes had been applied to a blood clot for some time.

On the left side, where no gross subdural clot had been observed, examination of the dura mater, nevertheless, revealed red cells in an organizing network (fig. 8). In other areas in which no red cells were present, there were pigment-laden phagocytes within the dura. This is evidence that, although no clot was to be seen grossly in this region, there had been at one time a thin subdural layer

Fig. 7 (case 3).—Microscopic appearance of a section of the meninges taken from the right side, showing a partly organized blood clot in the lower portion of the field and the dura containing pigment-laden phagocytes in the upper part.

of blood. It may be significant that the subdural space was closed more densely by adhesions on this side than on the other, where the clot was visible. This suggests that a very thin layer of blood may result in closure of the subdural space, in contrast to the effect of a true hematoma of greater thickness, which causes less adhesion.

This case is an important link in the analysis of the pathologic anatomy of this condition. The headache developed after a longer period than usual after the blow, but the pain was then constant, typical and associated with characteristic bouts of dizziness. The completely normal subarachnoid system shown in figure 5 and the normal ventricles visualized in the second set of encephalograms rule out gross pathologic alteration of the cerebrospinal fluid spaces. The obliteration of the subdural space, with adhesions too dense and too widely extended to yield as yet to our therapeutic efforts, represents the only pathologic con-

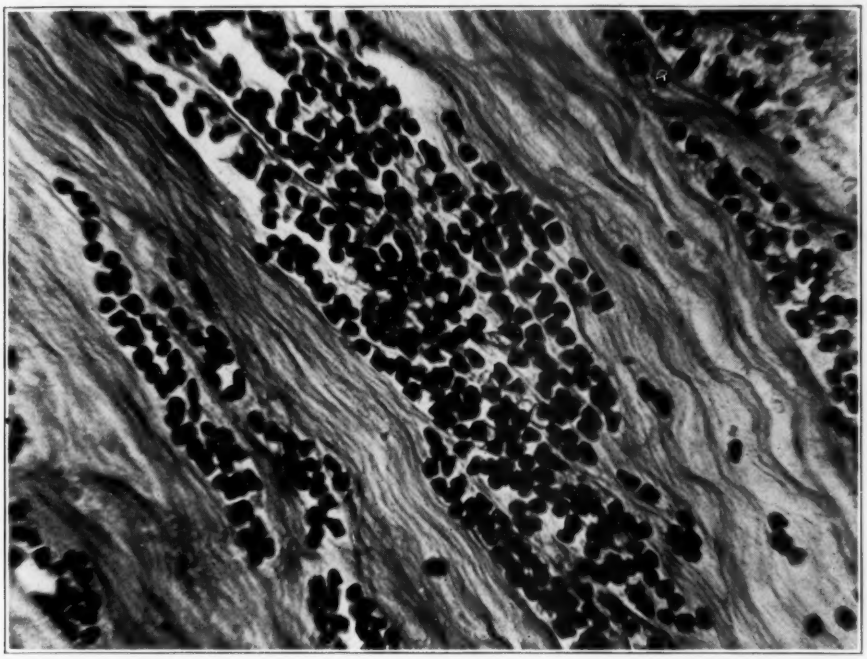

Fig. 8 (case 3).—Microscopic appearance of a section of the dura on the left side, showing red blood cells between the layers.

dition and makes clear what must be the cause also in less severe conditions.

In the following three cases, the condition, which was resistant to treatment with spinal insufflation, responded to cranial subdural insufflation. They may be cited as examples.

Case 4.—In 1931 a woman struck her head against a chandelier. Three weeks after this accident there was onset of headache and dizziness, accompanied with fever that lasted for two weeks. Since this time headache had been constant, but the dizziness disappeared spontaneously at the end of fifteen months. The patient remained free from the spells of dizziness for twelve months, but they

recurred two months before her admission to the hospital. On March 31, 1934, trephine holes were made in the right postfrontal and postparietal regions. Forty cubic centimeters of spinal fluid was allowed to escape, through a lumbar puncture, and the brain fell away. The patient was discharged much improved, and a recent report stated that she had been free from headache but still had occasional attacks of slight dizziness.

CASE 5.—In October 1934 a man was struck on the left frontoparietal region by a falling rock. He had headache and transient dizziness constantly thereafter. In June 1935, at another hospital, lumbar insufflation of air was instituted, and fifteen intravenous injections were given, with no relief. On August 28 lumbar insufflation of air was employed. The arachnoid was well filled, and no air found its way into the ventricles. Plates taken on the second day showed a large amount of subdural air over the frontal pole, but as no plates were taken with the occiput uppermost, it was impossible to state the condition of the subdural space posteriorly.

The patient was not relieved after this procedure. On Oct. 3, 1935, trephine holes were made in the left frontal and parietal regions. The subdural space seemed to be under increased pressure, and the arachnoid bulged through the dura and wept fluid. Sixty-five cubic centimeters of fluid was removed through lumbar puncture, and the brain fell away. No definite adhesions could be felt on passing an instrument through the subdural space, although resistance seemed to be encountered. At two points of the parietal portion of the dura pressure outward gave pain that was somewhat like the usual headache. After this procedure the typical headache disappeared. The dizziness was improved at the time of writing. A recent examination revealed that the patient had no typical headache but still suffered from dizziness.

CASE 6.—On June 26, 1935, the man fell, striking the right side of the head. After the fall he had headache in the right parietal region and transient attacks of dizziness. On July 13, 1935, lumbar insufflation of air was carried out. A great deal of air entered the ventricles, and not much appeared in the subarachnoid space. No improvement resulted. On August 26 a second lumbar insufflation of air was carried out. This time there was no air in the ventricles, and the subarachnoid space was well filled. On the second day spotty collections of air were seen over the frontal pole and the right parietal region, but no appreciable amount of air was seen in the subdural space. As one would expect, the patient obtained no relief from this procedure.

On October 29 trephine holes were made in the right frontal and parietal regions, and 75 cc. of spinal fluid was allowed to escape through a lumbar puncture, the brain falling away by virtue of the air that entered the open dura. An instrument was passed into the subdural space, and adhesions were noted in the occipital region. Over one portion of the occipital lobe pressure outward on the dura produced pain that resembled the headache. This procedure was repeated twice. A recent report from the family physician stated that the patient was free from all complaints.

EXPERIMENTAL STUDY

In an attempt to duplicate in the laboratory the lesion observed in patients, a series of cats was subjected to experimental trauma. The trauma consisted of a blow on the vertex with a soft round wooden stick. The immediate mortality and that resulting within forty-eight

hours was high, the causes being severe fracture and massive subdural hemorrhage. The animals which survived were studied in a number of ways.

Eight surviving animals were studied as follows: In from two to twenty-two days after the trauma the cats were killed by anesthetization with 0.5 cc. of dial per kilogram of body weight, and saline solution followed by formaldehyde was injected into the carotid arteries. The skin and muscles were removed from the head, and the animal was then completely frozen. The heads were sectioned in disks with a saw by means of a technic previously described,[10b] and the subdural and subarachnoid spaces were studied while the blocks were still frozen, so that distribution of fluid could be inspected. After this the sections were thawed, studied macroscopically for subdural adhesions and embedded for microscopic study.

In five of the eight animals subdural adhesions were shown. They were very delicate and were confined to the region of the vertex where the blow was struck.

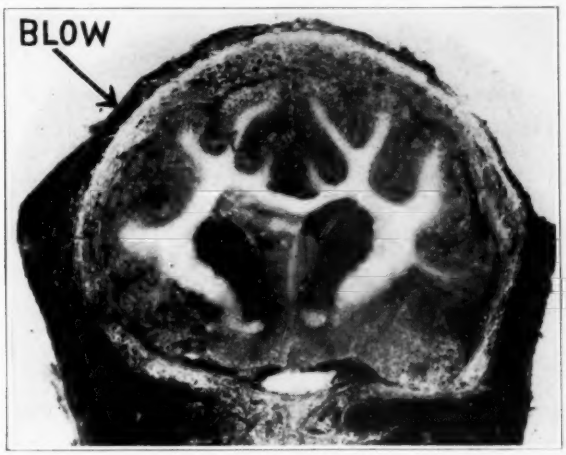

Fig. 9.—Cross-section of the skull and brain of a cat which had received a blow at the site indicated by the arrow. The whole head had been frozen, and the segment was still frozen when photographed. The subdural space was closed near the blow, but not elsewhere.

None was observed at the sides or the base, where increase of subdural fluid most often occurred. In figure 9 is shown a transsection through the head of a cat while still frozen. The arrow indicates the site of the blow and the site of major delicate adhesions between the dura and the arachnoid, visible first on gross inspection and later in microscopic sections. It is obvious that the fluid normally present in the subdural space and visible elsewhere, especially over the temporal lobe on the opposite side, is absent beneath the site of the blow. This is the condition which actually obtained during life and which could be demonstrated only by freezing.

In only two of the five cats could the brain with dura attached be removed from the rim of the bone without breaking the subdural adhesions. These two brains were studied microscopically. They showed a network of delicate, faintly

staining strands of connective tissue extending from the dura to the arachnoidea. Further cytologic studies were unsatisfactory, because freezing had obscured nearly all cellular detail. It was evident, however, from the study of all the cases that blood cells were present early and that at least twenty days later connective tissue was present.

To reproduce a shift of the brain within the dura a group of cats was studied with the use of the following technic: A small bur hole was made in the vertex of the skull near the midline; a hypodermic needle was thrust through the intact dura into the brain, and a small amount of 1 per cent aqueous solution of trypan blue was left in the track of the needle as it was withdrawn. The skin was sutured, and the animals were subjected to trauma as before. At intervals varying from five to eleven days they were killed. Dial anesthesia was used, and a large button of bone surrounding the original bur hole was removed. Through the dural scar, previously used for puncture, another hypodermic needle was inserted perpendicularly into the brain, and lampblack was left in this track. The dura was then carefully reflected, and the puncture wounds, colored blue and black, respectively, were studied. In nine of the ten animals studied in this way the two punctures corresponded, while in the tenth animal they were about 0.5 mm. apart. In only two cats of this series were definite adhesions demonstrated. If adhesions were present in the other animals they were so delicate that they were broken in reflection of the dura. It was in one of these two instances that the brain had been shifted by the blow.

In a further series of ten cats used as controls, a less severe blow was administered. In this series, with the use of the same technic already outlined, no shift was observed, the two punctures coinciding, and no adhesions could be demonstrated.

Macroscopic study showed that the subdural lesion was composed of delicate adhesions between the dura and the arachnoid, situated at or near the vertex where the blow was struck. In places the dura and the arachnoid were closely adherent, while in other spots they were connected by many delicate threads of connective tissue. No gross hemorrhage was noted, except in the subjects which did not survive.

On microscopic examination one was impressed first by the extent of the delicate adhesions covering the greater part of the upper surface of the brain and binding the dura to the arachnoid more or less intimately. These adhesions were, for the most part, fibrous bands or cords, rarely more than a few cells in thickness. Hemorrhages were noted both in the dura and between it and the bone. In places the dural tissue was split by such hemorrhages for some distance. Often underlying the dura in the subdural space was a very thin hemorrhagic sheet, especially in the animals that were killed early. In the animals killed later this sheet tended to be replaced by young fibrous tissue. In some areas might be seen macrophages and occasional leukocytes—cytologic evidence of the phagocytic process that accounted for the disappearance of the clot during its organization.

SUBDURAL ESCAPE OF AIR

In twenty-two of the twenty-five cases to be reported in which spinal insufflation was used for the relief of headache, roentgenograms were taken on the second day. In ten of these cases a large amount of air appeared in the subdural space, in eight a considerably smaller amount and in four none. As controls, the encephalograms for eighteen patients

with epilepsy and four with psychoneurosis were examined. In each instance plates taken on the second day were available. There was no escape of air into the subdural space in these cases, except possibly in two instances in which a small amount of air may or may not have been present in the subdural space.

REPORT OF CLINICAL CASES IN WHICH TREATMENT WITH SPINAL INSUFFLATION WAS CARRIED OUT

Twenty-five additional cases of posttraumatic headache may now be reported. This list includes the cases of all patients in our clinic who received such a diagnosis during a period of five years and who could be followed up satisfactorily. They were all treated with spinal insufflation, without recourse to direct subdural insufflation, which will be used in the future when required. At the time of writing, in 56 per cent of these patients, by their own admission, the headache has been cured for periods varying from six months to five years. In an additional 12 per cent of the patients the headache was considerably improved, and in 24 per cent there was no improvement. In regard to the dizziness, 48 per cent of the patients reported complete cure and 24 per cent imrpovement, while in 16 per cent the dizziness was as marked as before insufflation.

These results were admitted by the patients in spite of the fact that the majority were receiving compensation for the disability at the time of treatment.

COMMENT

The lesion responsible for posttraumatic headache is situated in the subdural space, as indicated by the following observations:

1. In four cases definite adhesions were recognized in this space when an instrument was inserted through a trephine hole.

2. In one instance (case 3), in which the headache was severe and associated with mental change, a brown membrane, less than 1 mm. in thickness, was observed in the subdural space over one hemisphere, and on the other side the dura was thickened. Microscopic study on the side of the brown membrane showed that a thin layer of blood in the subdural space was undergoing organization and that it adhered to the arachnoidea as well as to the dura and, further, that blood had been present also on the side on which no gross subdural clot was seen, as indicated by the presence of pigment-laden macrophages (fig. 7).

3. As demonstrated in a number of cases, pressure on the undersurface of the dura by a curved instrument introduced through a small hole in the dura produced pain which, the patient stated, resembled the chronic headache in location and character. Such exploration with the instrument showed that in most areas the dura was insensitive. The pain usually came from one or two spots and might be reproduced at will. This suggested that the arteries of the dura were pressed on.

4. Analysis of the data in the twenty-five cases just reported shows that after spinal insufflation it could be seen in ten cases that the sub-

dural space filled well on the second day (although cystic collections indicated that in six cases the space was not completely opened). Seven of the ten patients were cured. On the other hand, in eight cases the filling of the subdural space was poor. In only one of these eight cases were both the dizziness and the headache cured.

5. The best evidence is the fact that introduction of air into the subdural space over the hemisphere cures posttraumatic headache in a high percentage of cases, which indicates that the etiologic lesion lies in this space and that the nature of the lesion is obliteration of the space due to frail but intimate adhesions between the dura and the arachnoid. The evidence seems adequate to conclude that the pathologic lesion associated with posttraumatic headache is situated in the subdural space and that adhesion of the arachnoidea to the dura causes constant traction or pressure on a sensitive area in the under-surface of the dura.

Typical posttraumatic headache is constant and is localized, as a rule, to the vicinity of the point at which the head is struck, except that when the blow is over the occiput the pain is often complained of in the frontal region. The anatomic studies reported here indicate that the only sensitive intracranial structure that may be affected by such an injury lies in the dura mater. Stimulation of the dural arteries on the convexity of the dura enables the patient to localize the pain accurately. However, stimulation of dural sinuses that lie posteriorly is likely to give rise to pain which is referred forward to the frontal region. Contrecoup injury may affect the brain on the opposite side, but not the dura. Hence, a blow low on the occiput may cause a subdural lesion in this region from which pain is referred forward.

The mechanism of production of this pathologic condition may be described on a hypothetic basis as follows: The skull is struck, and injury to the underlying dura is produced, which results in the outpouring of a thin layer of blood and exudate into the subjacent subdural space. A thin carpet of blood clot is thus formed, which because of its fibrin acts as a sort of intimate cement. The red cells which may be present are absorbed, but the membranes remain adherent. A further factor may enter here. The force of the blow may alter the normal relation between the brain and the skull so that the adhesion forms with the brain rotated out of its normal position. As the traumatic edema of the brain disappears, the tendency of this organ to move back to its normal position may well exert a gentle but constant traction on the area of dura to which it has become attached.

Headache on the basis of this mechanism is produced if the traction is exerted on one or more of the sensitive areas of the dura, it being remembered that the major portion of the dura is insensitive. Relief of headache follows separation of the arachnoid from this sensitive area or areas.

Dizziness, which is often an important factor in the symptom complex, can scarcely result from traction on sensitive dura, and no patient has complained of dizziness when the dura was stimulated experimentally. The dizziness must be the effect of the traction on the brain itself. As an instance of the production of dizziness by traction on the brain, cases in which a large cranial window is produced by the removal of bone may be cited. It is a common experience that a patient with such a window becomes dizzy on stooping or straining. This is probably due to the fact that the enlargement of the intracerebral veins thus produced displaces the brain through the cranial window to some extent.

Patients with posttraumatic headache suffer dizziness when they stoop, strain or move the head quickly. The dizziness does not resemble that of labyrinthine origin. It is not associated with nystagmus, nor is it accompanied by a sense of persistent rotation or nausea. It seems likely that the movements here described increase the traction on the brain somewhat and thus produce the dizziness.

Relief from dizziness results with the use of insufflation when the major portion of the traction on the brain is released, regardless of any relation to the sensitive areas of the dura. In actual experience the employment of insufflation may relieve both the headache and the dizziness, or it may relieve one and not the other.

According to the foregoing explanation, adhesions which occur between the arachnoid and the dura in such a way that the brain does not exert traction on the dura give rise neither to headache nor to dizziness.

THERAPEUTIC INSUFFLATION

It follows from this analysis of the pathologic basis of posttraumatic headache that therapeutic insufflation can be employed effectively in one of two ways, as will be described. In each case the primary object must be to introduce air over the cerebral hemispheres (occasionally over the cerebellum) and to keep it out of the ventricles. In ten of the twenty-five cases reported in this paper, no air appeared in the ventricles immediately after insufflation, and in 60 per cent of these instances the patient was permanently cured. In fourteen cases there was filling of at least one half of a lateral ventricle, and in only 36 per cent of this group was cure effected.

First Method.—Intraspinal insufflation is carried out, as described [1] in 1927:

> The patient is placed on his side on a table the head of which is elevated, and the patient's head is rotated 45 degrees toward the ceiling (fig. 10). In that position air can pass up the spinal spaces into the cisterna magna and thence into the cerebellopontile angle and forward into the basilar cisterns. From there it reaches the subarachnoid spaces over the hemisphere in the area lying uppermost, which should be the area of maximum chronic ache.

If the head is dropped downward a little so that the direction of slant of the aqueduct is downward, it becomes impossible to fill the ventricles. While the air passes upward in the basal cisterns spinal fluid continues to escape from the ventricles, so that they must become wholly or partially collapsed (fig. 11 *A* and *B*). Ten cubic centimeters of fluid should be removed first, and then air injected and fluid removed alternately in amounts of 10 cc. When from 50 to 80 cc. of fluid has been removed, the pressure is measured, and the injection of air is continued

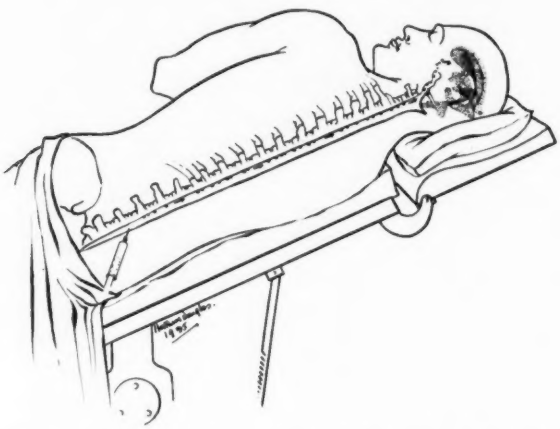

Fig. 10.—Diagram indicating the position of the patient for spinal insufflation. Air passes upward into the basal cisterns and subarachnoid spaces while fluid is alternately withdrawn from each ventricle. The patient does not face directly toward the ceiling, but the head is rotated only half-way from the horizontal to the perpendicular.

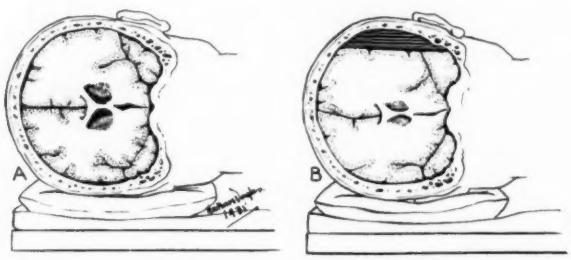

Fig. 11.—Diagram illustrating (*A*) the ventricles normally filled with fluid, and (*B*) collapse of the ventricles and the corresponding separation of the pia and the dura as the air collects in the subdural space.

until the initial spinal fluid pressure is reached. General anesthesia should be avoided, as it causes the brain to swell. The use of scopolamine hydrobromide ninety minutes before the injection and generous administration of morphine immediately before are adequate to control the pain. Roentgenograms may be taken at once and again the next day. The patient must be kept flat in bed, and most of the time during the next day or two his head must be placed so that the air may collect at the site of the former pain.

Second Method.—A method not previously described is direct intracranial subdural insufflation.

The patient is placed so that the side of the cranium on which the headache is felt is uppermost. A small trephine hole is made, and the dura is carefully opened so as not to wound the arachnoidea. An assistant performs a lumbar puncture, and the fluid is allowed to escape from the needle freely as long as possible, the table being tipped so that the ventricles drain as completely as may be. Air is thus aspirated into the subdural space, and the brain falls away from the dura and must remain so until the air is absorbed. The scalp is then sutured in two layers.[12]

If it is desired, during the first week after trepanation the patient may be placed in the sitting posture for lumbar puncture and cerebrospinal fluid withdrawn while a small hollow needle is introduced through the scalp into the trephine hole to allow passive aspiration of air into the subdural space.

With this method, why does the air appear in the subdural space the day after lumbar subarachnoid injection? It is known that the subdural and the subarachnoid fluid are normally separated efficiently by the arachnoidea and that the fluids are of different color and protein content, as already described. It seems likely that when a large amount of air has been introduced into the subarachnoid spaces but not into the ventricles, the weight of the brain as the head is moved is sufficient to rupture the thin arachnoidea, particularly when this membrane is adherent to the dura. Possibly this rupture is always due to adhesions between the arachnoid and the dura as encephalography in other cases rarely results in escape into the subdural space.

SUMMARY

The subdural space under normal circumstances contains a small body of fluid quite separate from the cerebrospinal fluid. Small movements which occur between the brain and the skull when the head is moved quickly are probably made possible because of this fluid bed. Such movements between the pia and the arachnoid are impossible because of the tissue septums which normally connect these membranes.

The pathologic basis of true posttraumatic meningeal headache consists in an intimate adhesion of the arachnoidea to the dura, which causes obliteration of the subdural space in a smaller or larger area. This does not mean dense adhesions, such as those of a scar. The sen-

12. We have introduced an instrument into the subdural space before closure, as already mentioned, and we have also injected air under pressure beneath the incision after the scalp was securely closed. Both of these procedures, however, may be dangerous and should never be used with the patient under general anesthesia or as a routine, since a vein connecting the brain and the sinus may thus be ruptured. Subdural hemorrhage occurred in one of our cases. The procedure should be limited to passive entrance of air while cerebrospinal fluid escapes from the lumbar puncture needle.

sitive area which is likely to be affected by this adhesion is usually a meningeal artery in the dura or, less frequently, a dural sinus. The chronic pain is due to pressure or traction on one of these sensitive areas because of the rotation in position of the brain produced by the blow and maintained by the adhesion. A hypothetic analysis of the manner in which this condition is brought about by trauma may be found under the heading "comment."

Effective therapy must provide for collapse of the ventricular system and the simultaneous introduction of air into the subdural space, as shown in figure 11. As the head is oscillated, the brain, which is shrunken because of the collapse of the ventricles, pulls away from the overlying dural covering with considerable traction due to its own weight. This separation accounts for the cure which results from proper insufflation of air. Failure may occur when this reopening is incomplete, and adhesion continues to stimulate a sensitive area of dura.

DISCUSSION

Dr. Francis C. Grant, Philadelphia: It has long been known that the best results in the relief of headache with the use of encephalography are obtained in cases in the posttraumatic group, and this opinion has been reenforced by Dr. Penfield's work. I wish to ask Dr. Penfield several questions: What does he believe to be the pathways over which this pain leaves the dura? If the cause of the headache is close adhesions between the arachnoid and the dura, why does not localized headache occur after every craniotomy with decompression? In all these cases, whether the dura is left open or whether it is closed, adhesions between the arachnoid and the dura or the overlying muscles always occur. Yet localized headache is rare. My last question is: What is the danger of bleeding from a vein, let me say, between the cortex and the dura when one introduces a curved instrument through the trephine opening and breaks up the adhesions?

It seems to me that Dr. Penfield and Dr. Norcross have taken a definite step ahead in the treatment of patients with posttraumatic headache. In the conditions which have been outlined in this paper by Dr. Penfield and Dr. Norcross, their treatment certainly seems to follow logical lines.

Dr. Wilder G. Penfield, Montreal: In answer to Dr. Grant's questions, I may state that the pathways of definite pain must be pathways within the dura. The convexity of the dura is sensitive only at points where the middle meningeal artery and its branches occur. These fibers pass downward along the middle meningeal artery. Occasionally a meningeal vessel conducts afferent fibers toward the midline. Thus, it may be sensitive even after it is cut off from the middle meningeal artery. Therefore, the innervation of the dura of the convexity may also come sometimes from the midline. I do not know from what nerve these midline fibers are derived. Further, the conduction may be, and certainly is in some cases, along the dural sinus, and in that case the sinus is not innervated by the nerve plexus of the meningeal artery. I am not sure how it is innervated. This subject is being studied by Dr. McNaughton.

Dr. Grant's observation about the bone flap is pertinent. Every surgeon knows that after a bone flap is replaced subdural adhesions are formed. Sometimes also when one turns a bone flap down in a case of old trauma, there are adhesions, and

yet the patient perhaps never had a headache. My explanation is that in cases of traumatic headache there is shifting of the normal relationship of the brain to the overlying dura, so that traction is eventually exerted on the adhesions. My co-workers and I have been able to reproduce such a shift in only one of the animals in our series.

It is important to remember the danger of energetic direct injection of air beneath the dura. We have in one case caused bleeding from a vein which joined the brain to the dura by using an instrument such as Dr. Grant suggested. For this reason we carry out none of these direct procedures without having the patient conscious, and we are guided to a great extent by his feeling of pain. We have never seen, however, any evidence of injury to these veins following the intraspinal injection of air.

OCCLUSION OF THE ANTERIOR SPINAL ARTERY

CLINICOPATHOLOGIC REPORT OF A CASE AND A REVIEW OF THE LITERATURE

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The syndrome of occlusion of the anterior spinal artery consists of sudden paraplegia accompanied by anesthesia and by disturbances of urination and defecation. The anesthesia is dissociated, of the syringomyelic type, in which there is complete loss of the sensations of pain and temperature with preservation of the sensations of touch, position and vibration. The cause of this syndrome is destruction of certain portions of the spinal cord by a sudden occlusion of the anterior spinal artery or its branches. This symptom complex is so definite that it permits of an accurate clinical diagnosis, the symptoms varying somewhat with the level of the occlusion. Clinical, and especially pathologic, reports on this syndrome are exceedingly few. It was first described in 1904 by Preobrajensky,[1] who believed that its most probable cause was syphilis. Syphilis was also the etiologic factor in the cases of Spiller [2] and Margulis.[3] In the case of Grinker and Guy [4] the cause was subluxation of the cervical vertebra, while in Stanilowski's [5] case it was arteriosclerosis. This was also the cause of the occlusion of the anterior spinal artery in our case.

Read before the Chicago Neurological Society, Dec. 19, 1935.

From the Pathology Laboratories of the Cook County Hospital, Dr. R. H. Jaffé, director, and the Division of Neuropathology (Dr. G. B. Hassin) of the Department of Neuropsychiatry, University of Illinois, College of Medicine.

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REPORT OF CASE

History.—C. P., a white woman, aged 45, entered the neurologic ward of the Cook County Hospital on Jan. 2, 1935. She complained of inability to move the lower extremities and of retention of the urine and feces of five days' duration.

Prior to the onset of paraplegia she had been well. While she was eating breakfast one morning there developed severe pain across the chest, beneath the sternum. She immediately went to bed and one hour later was unable to move the lower extremities. The paralysis was associated with retention of urine and feces. Her daughter, a nurse, catheterized her before bringing her to the hospital.

The past history was essentially unimportant. The patient said that she had never had syphilis and had never used alcohol or drugs excessively. The family history was irrelevant.

Examination.—The patient was well nourished and well developed and did not appear to be acutely ill. The temperature was 99.8 F.; the pulse rate, 72, and the respiratory rate, 22. The blood pressure was 98 systolic and 68 diastolic. The heart and abdominal organs were essentially normal, except that the urinary bladder was markedly distended. Auscultation revealed a few crepitant râles over the apex of each lung. The teeth were in a very poor condition; all of them were carious, with marked pyorrhea.

The head, cranial nerves and upper extremities were normal. There was flaccid paraplegia of the lower extremities. Complete loss of sensations of pain and temperature, extending from the second thoracic dermatome downward, was noted. The sensations of touch, position and vibration were preserved throughout.

There was absence of the patellar, achilles tendon and abdominal reflexes bilaterally. Pathologic reflexes were not elicited. There was no atrophy or vasomotor disturbances.

Laboratory Data.—Spinal puncture revealed a clear fluid under normal pressure. The Queckenstedt test showed no spinal block. The Pandy reaction was negative, and there were 8 cells per cubic millimeter. The Wassermann reactions of the blood and spinal fluid were negative. The urine was normal. The urea nitrogen content was 15.8 mg. per hundred cubic centimeters. Culture of the blood revealed no growth.

Roentgenograms of the cervical and dorsal portions of the spine disclosed no definite changes.

Course.—A catheter was inserted, and the bladder was irrigated with a 1 : 10,000 solution of potassium permanganate daily. Three weeks later the temperature became elevated, and a small pressure sore appeared on the right buttock. As the pressure sores grew larger the temperature became septic.

On January 25, mild bilateral defense reflexes and normal plantar responses were elicited. The knee and achilles tendon reflexes could not be obtained. Later a very toxic state developed. The defense reflexes disappeared, but the sensations of touch and position remained unchanged. The diagnosis was myelomalacia, i. e., softening of the spinal cord (with preservation of the posterior columns), probably of vascular origin because of the sudden onset, though the dissociation of sensibility (preservation of the sensations of touch and position) also suggested disseminated myelitis and hematomyelia.

The patient died on March 20, approximately eleven weeks after entrance to the hospital.

Necropsy (Dr. R. H. Jaffé).—A routine autopsy was performed, but the brain was not examined as permission for this was not given. The essential

observations on gross examination were: severe atheroma of the branches of the anterior spinal artery, with extensive softening of the anterior half of the spinal cord, most marked in the midthoracic portion; chronic indurative tuberculosis in the upper lobe of the right lung with cavity formation; acinose dissemination about this area and in the lower lobe of the right lung; severe decubitus ulceration; hemorrhagic cystitis; marked fatty changes of the liver; parenchymatous degeneration of the myocardium; focal bronchopneumonia in the lower lobe of the right lung; adenoma of the right adrenal gland; nodose goiter, and evidence of a previous salpingo-oophorectomy on the left side.

Macroscopic Observations: Only the essential macroscopic changes of neurologic interest found in the spinal cord will be recorded. On removal of the spinous processes in the midthoracic region, the epidural fat tissue was found to be increased in amount and markedly injected, but there was no evidence of external pressure on the spinal cord, the ventral half of which appeared definitely softened on palpation. After the cord had been fixed in a solution of formaldehyde the anterior spinal artery and the dorsal spinal arteries appeared thin-walled, patent and without gross changes.

Sections of the spinal cord in the thoracic region revealed the anterior portion transformed into a semiliquid, yellowish, creamy mass. This escaped freely on the slightest pressure on the leptomeninges. It involved both the gray and the white matter and completely obliterated the normal markings of the spinal cord. The posterior columns of the cord were firm and exhibited no gross changes except for a small translucent area in the most ventral portion of the posterior columns of the lower part of the cervical and the thoracic region.

Microscopic Observations: Transverse sections taken for routine microscopic study from the different levels of the spinal cord were embedded in pyroxylin and paraffin. Frozen sections were stained with sudan III for fat, and a number of other differential staining methods were used (Van Gieson's stain for connective tissue, toluidine blue for Nissl structures, Kossa's stain for calcium, hemalum and eosin, the staining methods for amyloid bodies and elastica and those of Weigert and Pal, Cajal, and Alzheimer and Mann).

The softening involved, as we have pointed out, the anterior half of the cord and extended from the sixth cervical to the tenth dorsal segment. The most extensive area of softening was present at the seventh dorsal segment. In this area the normal configuration comprising three quarters of the anterior portion of the spinal cord, including the gray and the white matter, was completely destroyed (D_7, fig. 1). This was replaced by a framework of capillaries, masses of gitter cells (fat granule bodies) and neural detritus. The gitter cells contained a small, dark, chromatin-rich eccentric nucleus within a honeycombed cytoplasm packed with lipoids, which stained orange-yellow with sudan III. Often these areas of softening were represented by almost clear spaces from which the gitter cells had fallen out, leaving a bare outline of the anterior portion of the spinal cord formed by the thickened pial membrane (D_5, fig. 1).

Above and below the level of the maximum involvement the areas of softening gradually decreased in extent. In the regions of the sixth cervical and tenth thoracic segments, for instance, there were focal miliary areas of softening that involved largely the anterior column of gray matter and a few focal areas in the anterior and lateral columns of white matter (C_6 and D_{10}, fig. 1).

In contrast, the posterior columns and a small area adjacent to the posterior roots revealed no evidence of softening. They remained unchanged, except for a small area in the most ventral portion of the dorsal columns, in the lower part of the cervical and the thoracic region (fig. 1).

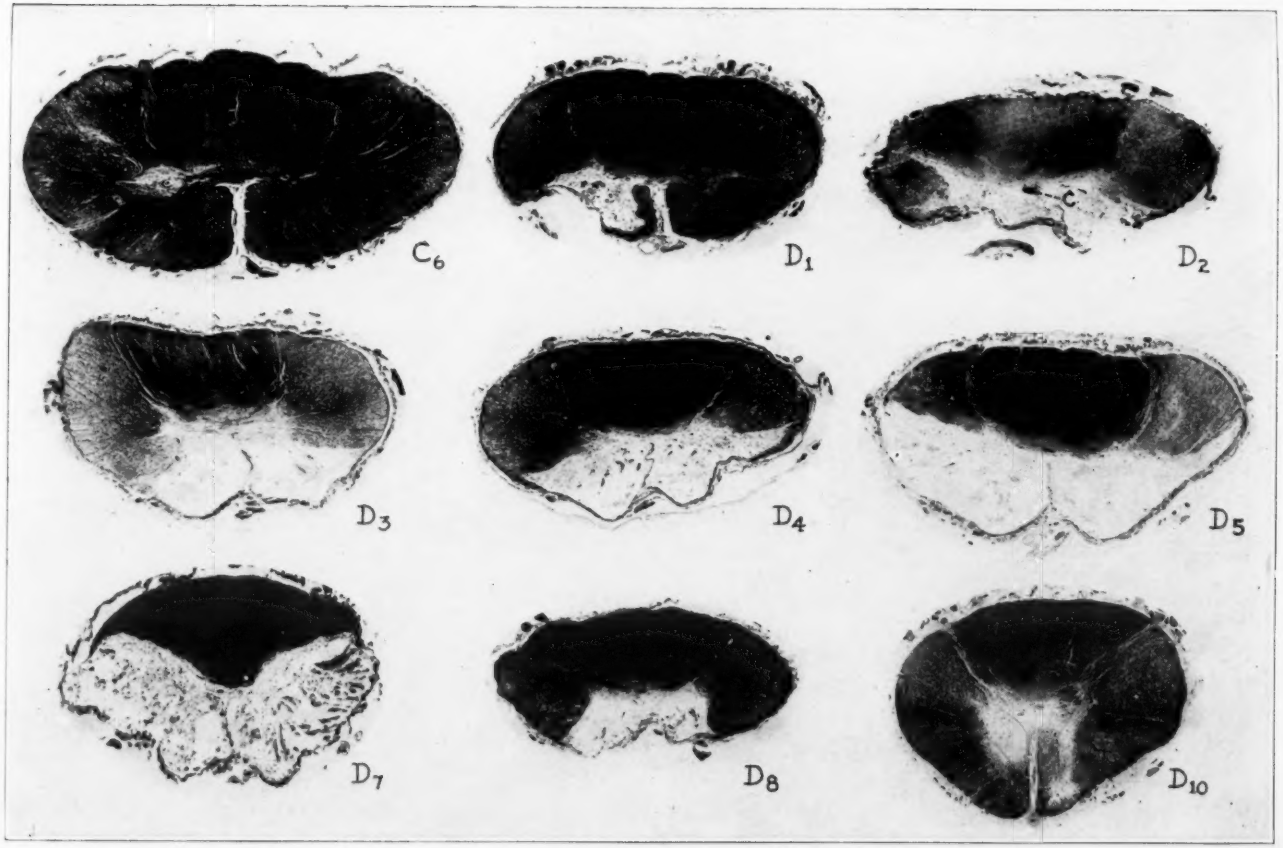

Fig. 1.—Photomicrograph of sections through various levels of the spinal cord, revealing softening in the anterior portion: C_6, focal miliary areas of softening (S); D_1, softening involving one anterior horn and adjacent white matter (S); D_2, calcium plaque in a sulcal vessel (C); D_5, thickened pial membrane (P); D_7, softening involving three quarters of the anterior portion of the spinal cord (S), and D_{10}, focal miliary areas of softening (S). Van Gieson's stain; low power magnification.

In the areas less involved and in the regions of focal miliary softening it was possible to demonstrate the cause of the vast changes described. Thus, the small arteries branching off from the anterior spinal artery exhibited severe atheromatous changes. At the second dorsal segment, in the median ventral fissure, the sulcal branch of the anterior spinal artery was almost completely occluded by a large calcified plaque (D_2, fig. 1 and fig. 2). The wall was eccentrically thickened and reduced the lumen of the blood vessel to a narrow slit. The thickening resulted from the deposits of compact clusters of calcified material in the intima and the adjacent media. The deposit of calcium was separated from the lumen by an intact layer or flattened endothelial cells (fig. 2).

Other arteries showed distinct eccentric thickenings of the intimal and medial tunics, which exhibited hyaline degeneration containing deposits of granules and

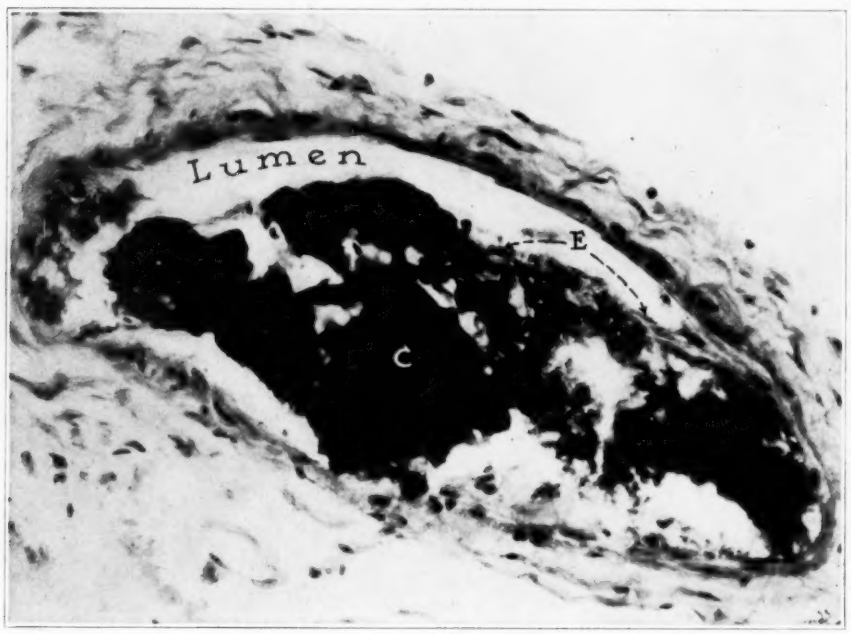

Fig. 2.—Higher magnification of *C*, figure 1, D_2. The sulcal artery at the second thoracic level revealed a huge calcified plaque almost completely obliterating the lumen. *C* indicates a mass of calcium bulging from the wall of the vessel, and *E*, endothelial cells lining the lumen. The narrowed lumen of the vessel is shown. Van Gieson's stain; × 360.

small plaques. As the Kossa stain and the nitric acid test demonstrated, the deposits consisted of lime salts. Occasionally sudanophilic droplets were found in the intima of some arteries. Severe atheromatous changes of the vessels were also found in the miliary foci of softening, which occasionally took the form of an ellipsoid (D_2, fig. 1) or a wedge-shaped area closely following the territorial distribution of the branches of the anterior spinal artery in the gray and the white matter of the spinal cord. The small dural and pial vessels as well as the cornal vessels branching into the periphery of the cord revealed similar changes (fig. 3).

In the focal areas of softening there were numerous newly formed blood vessels with markedly thickened and proliferated adventitia. These vessels were often massed into small groups and were surrounded by muffs of gitter cells (fig. 4 *A*). Fine connective tissue fibers were seen radiating from the periphery of these vessels among the gitter cells. The latter appeared enveloped by the fibers of the hyperplastic and thickened adventitia (fig. 4 *B*). The gitter cells were present not only in the perivascular spaces of the blood vessels of the spinal cord but in the spinal subarachnoid space (its ventral portion) and within the anterior roots themselves. As figure 5 demonstrates, gitter cells were scattered among the anterior root fibers, or rather among the parallel rows of their endo-

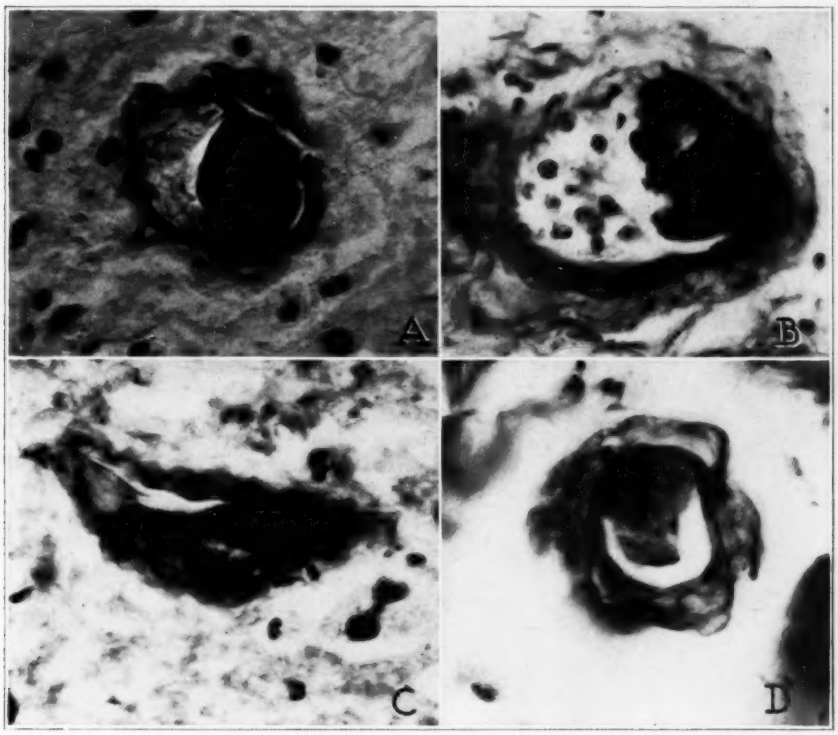

Fig. 3.—Photomicrograph revealing arteriosclerotic changes in the spinal blood vessels. *A* indicates the vessels in the anterior column; *B*, the vessels in the gray commissure; *C*; the coronal vessel, and *D*, a pial vessel. Van Gieson's stain: × 540.

neurial cells. In contrast, not a single gitter cell could be demonstrated in the posterior roots, where the configuration and the staining of the nerve fibers and their membranes exhibited nothing abnormal. In the anterior roots there was a definite prominence of endoneurial cells. Their apparent proliferation in some spots could be considered as a reactive phenomenon against the presence of gitter cells.

The posterior spinal artery and its numerous branches contained only slight thickenings in their walls, while in the area of softening of the ventral portion

of the dorsal column one of the terminal vessels (supplying the area of softening) was almost completely occluded by atheromatous changes.

The ganglion cells in the gray matter of the areas less involved revealed moderate or severe regressive changes, and throughout the spinal cord there was marked ascending and descending degeneration of the long tracts of nerve fibers.

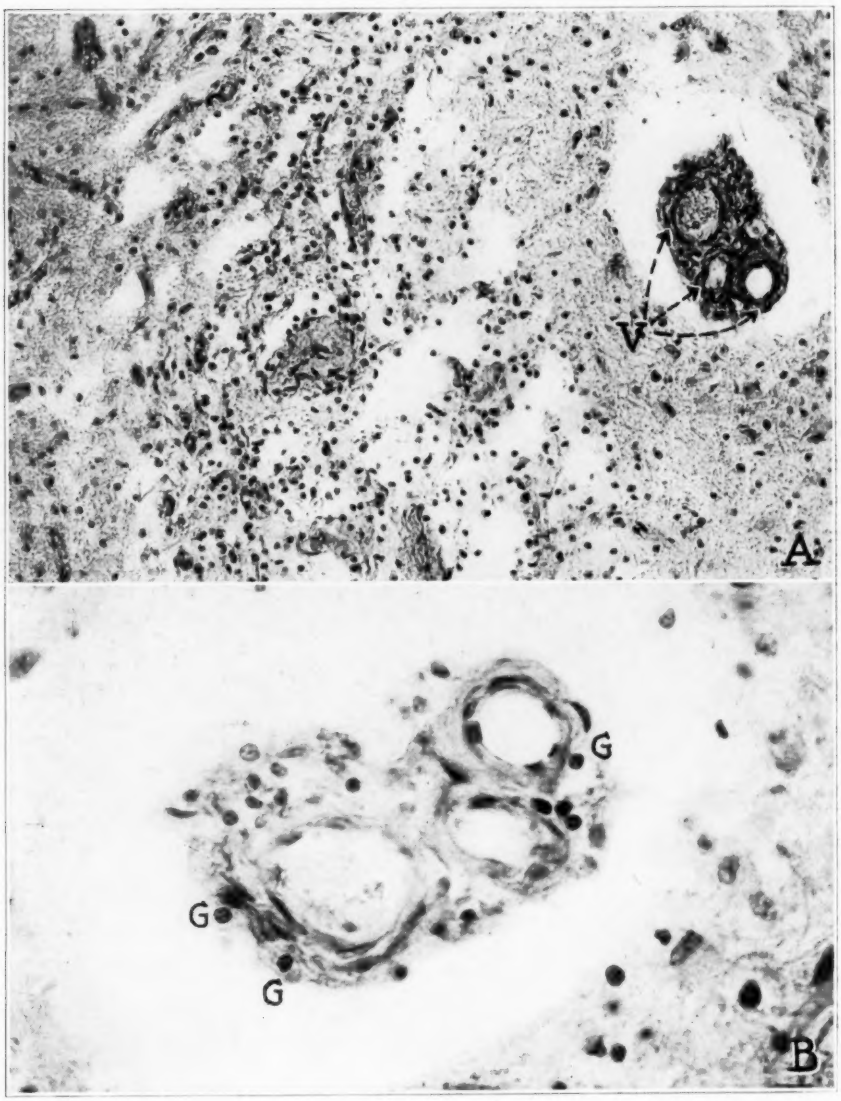

Fig. 4.—Photomicrograph revealing an area of softening with numerous newly formed capillary blood vessels surrounded by gitter cells. In *A* note the grouping of the blood vessels and the thickening of the adventitial walls (*V*). *B* is a higher magnification of *V*. *G* indicates gitter cells. Van Gieson's stain.

Throughout the region of the softening, especially at the periphery of the cord and in the subarachnoid space, small round colloid-like bodies were distributed. These bodies were evidently catabolic products (*Abbau* products). They stained blue with hemalum and eosin and violet with the method of Van Gieson, and failed to take the specific amyloid stain. The leptomeninges were markedly thickened, particularly over the anterior portion of the spinal cord.

In the lumbosacral area, Cajal's and other differential staining methods failed to reveal noteworthy changes except for secondary degeneration of the pyramidal

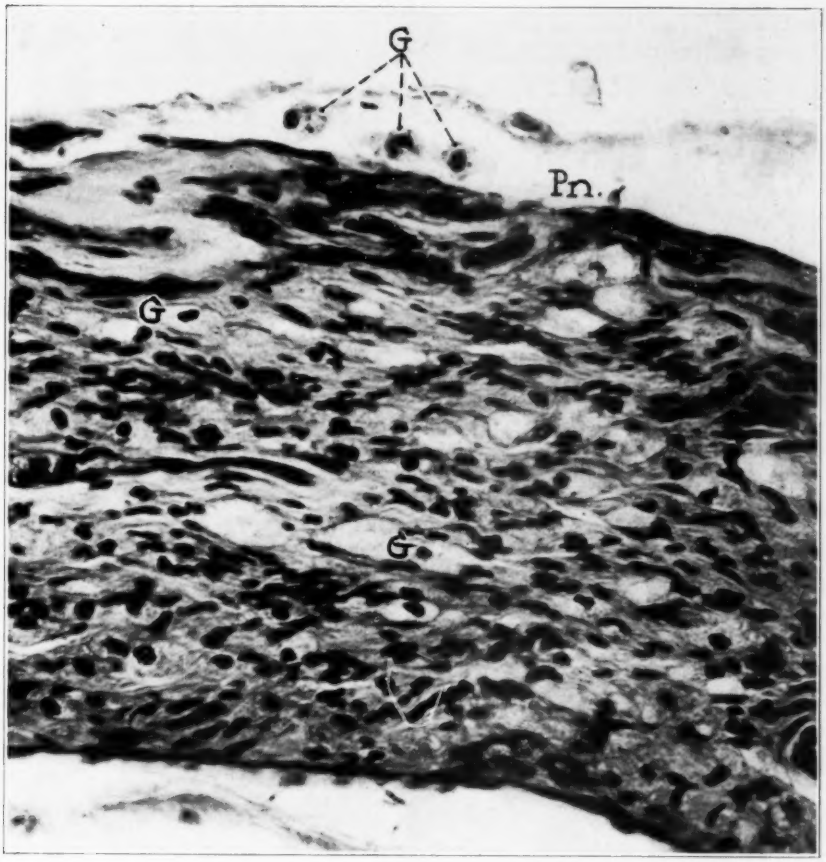

Fig. 5.—The perineurial space (*Pn*) contains gitter cells, which are quite numerous in the subjacent anterior root (*G*). The details are given in the text. Toluidine blue stain; high power magnification.

tracts. In the lumbar region the size of the anterior spinal artery was definitely larger than that at other levels.

There was no evidence of inflammatory elements throughout the spinal cord or about the pial blood vessels or of glial proliferation in the intact portions of the spinal cord.

The changes in other organs were of no particular interest. The intima of the ascending portion of the aorta and the transverse arch was smooth, and there was no evidence of syphilitic aortitis. The descending thoracic and the abdominal aorta revealed a few fatty and hyaline plaques.

A summary of the histologic changes follows: marked atheromatous changes of the anterior spinal artery and its branches; softening of the spinal cord, mainly of the thoracic region, where three quarters of the anterior portion of the cord was destroyed, corresponding to the distribution of the anterior spinal artery and its coronal branches; preservation of the posterior columns throughout, except for slight changes in its ventralmost portion, and ascending and descending degeneration of the cervical and the lumbosacral region.

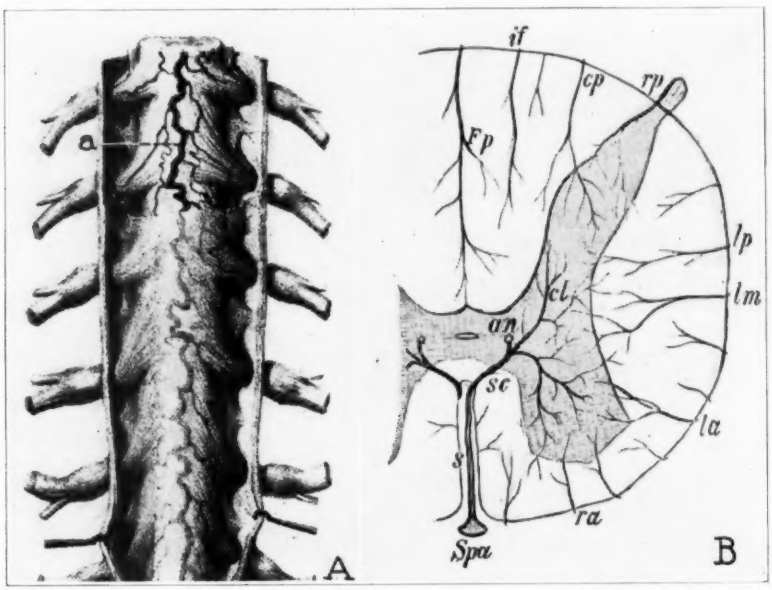

Fig. 6.—The course of the anterior spinal artery. *A* shows the anterior aspect of the cord, with a vessel in the pia; *a* indicates the anterior spinal artery. (From Hirshfeld.) *B* is a diagram of a transverse section of the spinal cord. *Spa* indicates the anterior spinal artery; *s*, the sulcal artery; *sc*, the suicocommissural artery; *cl*, the vessel to Clarke's column; *an*, the anastomatic branch, and *lm*, the coronal vessels. (From Obersteiner.)

COMMENT

In order better to understand the localization of the areas of softening described and their distribution, a knowledge of the vascular supply of the spinal cord is essential.

The anterior spinal artery, which arises from the vertebral arteries and is reenforced by lateral anastomotic branches from the abdominal aorta, supplies the anterior half of the spinal cord (fig. 6*A*). It sends large arteries into the ventral median sulcus (sulcal arteries) which

penetrate the commissure supplying the anterior horns and the adjacent white matter and smaller coronal branches to the periphery of the spinal cord (fig. 6*B*). In the cervical and lumbosacral regions the lateral anastomotic branches are large, and the blood supply is rich. The thoracic region possesses a poor blood supply, and this area is consequently vulnerable to vascular disturbances.

The posterior half of the spinal cord, on the other hand, is abundantly nourished by four large arteries, which course the entire length of the spinal cord, one on each side of the posterior roots. As these vessels are rich in anastomoses, vascular disturbances produce here little effect on the parenchyma of the cord unless they are extensive.

The peculiar blood supply of the spinal cord—separate systems for the anterior and posterior halves—must, when affected, produce characteristic clinical syndromes. A lesion of the anterior spinal artery, for instance, destroys the spinothalamic, pyramidal and other tracts of the anterolateral columns. Such a massive destruction must cause paralysis and sensory disturbances—loss of pain and temperature with preservation of the sensations of position, touch and vibration. The latter must all be preserved, as they are mainly conducted by the posterior columns, which, as has been pointed out, are supplied by a different arterial system. The additional involvement of the gray matter causes supplementary symptoms and signs, depending on the level of the lesion. For instance, occlusion of the anterior spinal artery at the level of the cervical enlargement will produce, as in Spiller's case, spastic paraplegia of the lower extremities and atrophic degenerative flaccid paralysis of the upper extremities (because of the involvement of the gray substance) and a dissociation of sensation below the end of the lesion with disturbances of urination and trophic disturbances. A lesion at the level of the thoracic portion of the spinal cord will also produce paraplegia, but without involvement of the upper extremities (our case), while a lesion at the level of the lumbar region will cause, as in Stanilowski's case, sudden flaccid atrophic paraplegia with disturbances of urination and defecation and trophic disturbances.

Regardless of the level of the lesion, the clinical picture in occlusion of the anterior spinal artery is that of myelomalacia. But the myelomalacia is, so to speak, not complete. Without going into lengthy discussions of different causes of myelomalacia, we wish to emphasize the fact that since the contributions of Bastian,[6] Williamson[7] and

6. Bastian, H. C.: Thrombotic Softening of the Spinal Cord: A Case of So-Called Acute Myelitis, Lancet **2**:1531, 1910.

7. Williamson, R. T.: Spinal Thrombosis and Hemorrhage Due to Syphilitic Disease of the Vessels, Lancet **2**:14, 1894.

Résumé of Cases of Syndrome of Occlusion of Anterior Spinal Artery with Autopsy Observations

Author and Date	Age and Sex	History and Onset	Clinical Findings	Essential Pathologic Changes	Extent of Softening	Etiology	Course and Duration
Stanilowski, 1905	62 yr. F.	Sudden onset with pain in lower extremities and paraplegia	Lower extremities: complete paralysis Bladder and rectum: retention of urine Reflexes: complete loss of achilles tendon, patellar and abdominal reflexes Sensation: of pain and temperature, lost below umbilicus; of position, intact in feet and legs	Obliteration of anterior spinal artery resulting in softening of anterior part of spinal cord	From tenth dorsal segment to conus medullaris	Syphilis (?)	Unchanged; illness; 3 mos.
Spiller, 1909	Adult M.	Premonitory symptoms: numbness and weakness in lower extremity followed by sudden onset of paralysis after lifting heavy blocks of ice	Upper limbs: flaccid paralysis with atrophy of muscles Lower limbs: spastic paralysis Bladder and rectum: incontinence Reflexes: patellar reflexes were exaggerated; Babinski sign present on right side Sensation: touch, intact throughout; pain and temperature, impaired in upper part of thighs, over the trunk as high as first rib; position, preserved	Occlusion of anterior spinal artery and its branches with much thickening of vessel walls, resulting in softening of anterior part of spinal cord	From fourth cervical to third thoracic segment	Syphilis	Unchanged; illness; 3 yrs.
Grinker and Guy, 1927	15 yr. M.	Vertebral sprain due to excessive muscular exertion following yawning and vigorous stretching of arms upward; a few hours later, upper extremities became powerless and shortly afterward complete paralysis of both legs	Upper limbs: markedly weakened with atrophy of muscles of hand and forearm Lower limbs: complete flaccid paralysis Bladder and rectum: complete incontinence Reflexes: absence of all deep and superficial reflexes Sensations: complete analgesia and thermal anesthesia below the fourth cervical dermatome; complete anesthesia below first lumbar dermatome except for a small area on medial and lateral surfaces of right ankle and toes of left foot; light touch preserved from fourth cervical to first lumbar dermatome; deep sensation preserved only in soles of both feet Wassermann reaction: negative	Thrombosis of anterior spinal artery followed by secondary myelomalcia	Lower cervical region; fourth, fifth and sixth cervical segments	Sprain of cervical portion of spine causing thrombosis of anterior spinal artery	Unchanged; illness, 1 mo.

Margulis, 1930, case 1	50 yr. F.	Prodromes: pain in lower extremities; sudden difficulty in lower extremities and urinary incontinence; syphilis denied	Upper extremities: unaffected Lower extremities: tonus diminished; bilateral Babinski sign Bladder and rectum: urinary incontinence Reflexes: All tendon reflexes lost Sensations: loss of pain and temperature from tenth dorsal dermatome downward; tactile sense in some areas, slightly decreased; absence of deep muscle sense only in left leg	Syphilitic endarteritis with secondary myelomalacia	Lower thoracic region and entire lumbar region	Syphilis	Unchanged; bed sores; sepsis, illness, 1 mo. and 5 days
Margulis, 1930, case 2	29 yr. M.	Weakness in legs and urinary retention followed by pain in legs, chest and small of back; one week later, complete paralysis of both lower extremities; syphilis in 1927	Upper extremities: normal Lower extremities: complete paralysis Bladder and rectum: retention of urine Reflexes: bilateral Babinski sign; hypotonia Sensations: pain and temperature, lost below fifth dorsal dermatome; touch diminished below fifth dorsal dermatome; subjective girdle sensation and pain in legs; deep sense Changes in the blood: no record	Syphilitic endarteritis with secondary myelomalacia	Midthoracic and upper lumbar regions	Syphilis	Decubitus ulceration; chills and fever; illness, 2 mos.
Margulis, 1930, case 3	36 yr. M.	Moist papules about the anus 3 mos. prior to onset for which only four injections of a mercuric preparation were given; moderate drinker; illness developed one day and weakness of the lower extremities the next	Upper extremities: normal Lower extremities: complete paralysis Bladder and rectum: urinary incontinence Reflexes: all tendon and skin reflexes lost Sensation: pain and temperature lost from seventh dorsal dermatome downward; tactile, deep muscle and vibration sense, retained	Syphilitic endarteritis with secondary myelomalacia	Thoracic and lumbar regions	Syphilis	Developed flexion contracture of lower extremities; decubitus ulceration; illness; 2 mos. and 8 days
Authors' case, 1935	45 yr. F.	Sudden onset with pain beneath the sternum followed by complete paralysis of lower extremities	Upper limbs: normal Lower limbs; flaccid paraplegia Bladder and rectum: complete retention Reflexes: absence of patellar, achilles, tendon and abdominal reflexes and Babinski sign Sensation: pain and temperature, lost from second dorsal dermatome downward Wassermann reaction of blood and spinal fluid: negative	Severe sclerosis of anterior spinal artery and its branches, resulting in secondary myelomalacia of the anterior part	From fifth cervical to tenth dorsal segments, inclusive	Arteriosclerosis	Gradually developed bed sores and sepsis; illness: 2½ mos.

Singer,[8] this form of lesion of the spinal cord must be considered not inflammatory (myelitis) but degenerative. It is a common occurrence, in contrast to myelitis, which is very rare. The clinical picture is that of paralysis, below the level of the lesion; it is always flaccid, regardless of the level, and is combined with anesthesia, which is also always complete, and absence of defense reflexes, disturbances of urination and defecation and trophic disturbances setting in early and severely.

In the myelomalacia produced by occlusion of the anterior spinal artery the clinical picture is, as we pointed out, incomplete. This is especially true of the condition of the sensibility, which is dissociated; of the defense reflexes, which may return, and of the condition of the tendon reflexes, which may be retained for some time.

Of the causes of either complete or incomplete myelomalacia, which we mentioned previously (syphilis, arteriosclerosis and trauma), that in our case was advanced arteriosclerosis. It caused almost complete obliteration of the anterior spinal artery. It should be emphasized that severe arteriosclerosis may alone lead to grave disturbances of the blood supply in the spinal cord without a concomitant thrombosis and that arteriosclerosis of the spinal arteries is much less common than elsewhere (Spielmeyer [9] and Davison and Keschner [10]). Yet several forms of arteriosclerosis of the spinal cord have been suggested. We may mention senile paraplegia (Leyden,[11] Démange [12] and Oppenheim [13]) and intermittent claudication (Dejerine [14] and Reichert [15]) as a partial manifestation of generalized arteriosclerosis (Pic and Bonnamour [16])

8. Singer, H. Douglas: The Pathology of So-Called Acute Myelitis, Brain **25**:333, 1902.

9. Spielmeyer, W.: Histopathologie des Nervensystems, Berlin, Julius Springer, 1922.

10. Keschner, M., and Davison, Charles: Myelitic and Myelopathic Lesions: III. Arteriosclerosis and Arteritic Myelopathy, Arch. Neurol. & Psychiat. **29**:702 (April) 1933.

11. Leyden, E.: Ueber chronische Myelitis und die Systemerkrankungen im Rückenmark, Ztschr. f. klin. Med. **21**:1, 1892.

12. Démange, E.: Sclérose médullaire d'origine vasculaire, Rev. de méd. **4**: 753, 1884.

13. Oppenheim, H.: Lehrbuch der Nervenkrankheiten für Aerzte und Studierende, ed. 7, Berlin, S. Karger, 1923, vol. 1.

14. Dejerine, S.: Sémiologie des affections du système nerveux, Paris, Masson & Cie, 1914, p. 267.

15. Reichert, F. L.; Rytand, D. A., and Bruck, E. L.: Arteriosclerosis of the Lumbar Segmental Arteries Producing Ischemia of the Spinal Cord and Consequent Claudication of the Thighs, Am. J. M. Sc. **187**:794, 1934.

16. Pic and Bonnamour: Des troubles médullaires de l'artériosclerose, Rev. de méd. **24**:4 and 104, 1904.

or as a complication of severe arteriosclerotic changes in the abdominal aorta (Winkelman and Eckel [17]).

The aforementioned forms probably differ from ours quantitatively but are by no means so typical clinically or pathologically as the forms in which the occlusion of the anterior spinal artery occurred from arteriosclerosis. In all cases of such involvement the prognosis is poor. It is much better in cases in which the condition is of syphilitic etiology, as is proved by the case of Spiller [2] (the patient lived three years) and the case of Schaller,[18] Ornsteen [19] and Margaretten [20] (only clinical reports).

In conclusion, we wish to emphasize one important pathologic phenomenon furnished by our case—the presence of gitter cells in the ventral subarachnoid space and the perineurial and endoneurial spaces of the ventral spinal roots of the spinal cord. In normal spinal cords, neither the anterior nor the posterior roots contain gitter cells. In the case reported here these cells could come only from the softened ventral portion of the cord, where they densely infiltrated the perivascular spaces of the blood vessels. As such spaces are in direct communication with the subarachnoid space and through the latter, that is indirectly, with the perineurial and endoneurial spaces of the spinal roots, it is logical to postulate that the gitter cells were discharged along the foregoing pathways from the spinal cord to its periphery. It is also logical to assume that in normal cords the same pathways are utilized for the discharge of the tissue fluids saturated with catabolic products. Originating in the parenchyma, the tissue fluids invade the perivascular spaces, from which they are discharged into the subarachnoid, perineurial and endoneurial spaces of the spinal roots. The pathologic phenomenon here described is a decided proof that elimination or "absorption" of the spinal fluid from the subarachnoid space occurs along the perineurial spaces of the roots of the spinal cord (Hassin [21]).

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17. Winkelman, N. W., and Eckel, J. L.: Focal Lesions of the Spinal Cord Due to Vascular Cord Disease, J. A. M. A. **99**:1919 (Dec. 3) 1932.

18. Schaller, W. F.; Roberts, A. M., and Stadtherr, E. F.: Syndrome of Occlusion of the Anterior Spinal Artery of the Fifth Cervical Cord Segment, J. A. M. A. **99**:1572 (Nov. 5) 1932.

19. Ornsteen, A. M.: Thrombosis of the Anterior Spinal Artery, Am. J. M. Sc. **181**:654, 1931.

20. Margaretten, I.: Syndrome of the Anterior Spinal Artery, J. Nerv. & Ment. Dis. **58**:127, 1923.

21. Hassin, G. B.: So-Called Circulation of the Cerebrospinal Fluid, J. A. M. A. **101**:821 (Sept. 9) 1933; Histopathology of the Peripheral and Central Nervous Systems, Baltimore, William Wood & Company, 1933.

CONCLUSIONS

A case of the syndrome of occlusion of the anterior spinal artery is reported in which the etiologic factor was spinal arteriosclerosis.

This syndrome, as first described by Preobrajensky, consists of sudden paraplegia, dissociation of sensibility of the syringomyelic type and disturbances of urination and defecation.

The syndrome may be caused by severe atheromatous changes of the anterior spinal artery, with or without accompanying thrombosis, and may lead to grave disturbances of the vascular supply with ensuing myelomalacia.

The myelomalacia is incomplete, leaving the posterior columns intact.

The softened tissues of the cord were discharged as gitter cells into the subarachnoid space and the perineurial spaces of the spinal roots, thus substantiating the theory that the discharge of the cerebrospinal fluid from the spinal cord is along the same pathways.

DISCUSSION

DR. G. B. HASSIN: On listening to the excellent presentation one may think it should not be difficult to make a diagnosis of occlusion of the anterior spinal artery. Yet there were tremendous difficulties in classifying the case reported here, for dissociation of sensibility may occur in cases of intraspinal tumor, meningovascular syphilis and other conditions. It was known that the condition was myelomalacia, but occlusion of the anterior spinal artery was not suspected, for the impression was that every occlusion of the anterior spinal artery must occur in the cervical region. At least in every case I know of, with the possible exception of the case of Stanilowski, there was such a localization.

In the absence of definite localization and etiology (trauma, syphilis and arteriosclerosis) the only diagnosis that could be made was incomplete softening of the spinal cord—incomplete myelomalacia. I think that one can make a diagnosis of occlusion of the anterior spinal artery only when the clinical picture shows involvement of the cervical region of the cord. The question I wish to ask is: How many cases of occlusion of the anterior spinal artery have been recorded in the literature in which the cervical region was spared?

DR. D. M. OLKON: I wish to refer to the case of a girl, aged 15, daughter of a physician, who while swimming was seized with sudden pain in the back and limbs and had difficulty in getting out of the water. She managed to walk to a car and went home. When she reached the house she could not walk upstairs. Her father found a "flaccid paralysis of the legs, some sensory disturbances and vesical incontinence." A competent neurologist thought the case was possibly one of occlusion of the anterior spinal artery. When I saw her the signs and symptoms suggested an atypical form of poliomyelitis. The girl was in bed for several months; notwithstanding the best of care, bed sores developed, and she continued to have vesical disturbances. She gradually improved and now, three years after the onset, has made a good recovery, although it is not complete, for she still has some sensory loss. From what Dr. Hassin has said in connection with Dr. Zeitlin and Dr. Lichtenstein's case, I wonder what the diagnosis was in this case.

One can hardly think of an endarteritis or malacia of the spinal cord in a child of the patient's age without any apparent precursors. Syphilis was ruled out.

Dr. G. B. Hassin: I saw the girl soon after the paralysis set in. I remember that the paralysis was associated with disturbance of sensibility in the lower extremities and that this developed suddenly after excessive dancing. The upper extremities were not involved. I was at that time and still am under the impression that the anterior spinal artery supplies the cervical region of the spinal cord, the lower parts being nourished mainly by branches from the aorta. The patient Dr. Olkon mentioned certainly did not have softening of the cord, which is an irreparable condition invariably leading to death.

Dr. Howard Zeitlin: I do not know of a case like the present one other than that of Stanilowski.

CELLS OF NERVOUS SYSTEM IN ACUTE AND IN CHRONIC MORPHINISM

CORRELATION OF CHANGES WITH BEHAVIOR

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AND
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Since 1925 the department of pharmacology at the State University of Iowa has been investigating the effect of morphine on tolerant and nontolerant dogs. During the process of addiction of a large series of dogs for these investigations, three died in convulsions, two while on increasing doses and one after withdrawal of the drug. The tissues from two of the animals, prepared by routine histologic technics, were examined by one of us (E. M. MacE.), with negative results (Plant and Pierce [1]).

On reviewing the literature at that time many papers were found which dealt with the recovery of morphine from tissues, the pharmacologic effects of morphine and the various types of treatment for morphinism, but little was found on the histopathologic picture during acute or chronic morphinism. The reports that were found on the latter phase of the subject concerned chiefly single cases in human beings, without comparison with controls (Spielmeyer [2] and Creutzfeldt [3]). No systematic attempt to correlate cellular changes and the behavior in laboratory animals was found.

In 1931 Ma [4] reported quantitative changes in the Golgi lipoid, definite alterations in the nucleus and slight changes in the mitochondria in the cells of rats, which he was able to correlate with profound physiologic disturbances during acute and chronic morphine poisoning and during withdrawal of the drug. Parallel changes were found not only

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1. Plant, O. H., and Pierce, I. H.: Studies of Chronic Morphine Poisoning in Dogs: I. General Symptoms and Behavior During Addiction and Withdrawal, J. Pharmacol. & Exper. Therap. **33**:329 (July) 1928.

2. Spielmeyer, W.: Histopathologie des Nervensystems, Berlin, Julius Springer, 1922.

3. Creutzfeldt, H. G.: Histologischer Befund bei Morphinismus mit Morphium- und Veronalvergiftung, Ztschr. f. d. ges. Neurol. u. Psychiat. **101**:97, 1926.

4. Ma, W. C.: The Cytopathology of Morphinism, Chinese J. Physiol. **5**:251 (Aug.) 1931.

in the cells from all parts of the nervous system but also in the cells from almost all the other tissues of the rats. These results are entirely at variance with our observations on the dog.

Horning [5] in 1934 reported "variable morphological changes" in the cells of rats under conditions of acute morphine poisoning. He stated that there are "more significant, but still inconstant, alterations in the cytoplasm" following addiction for periods of six months or more. His figures depicting the Golgi apparatus in cells from the posterior root ganglia of morphinized animals show only such variations as can be readily duplicated in sections from the posterior root ganglia of our control animals.

MATERIALS AND METHODS

Forty-four dogs were used in this investigation. Sixteen were adult dogs, old females of unknown age from the series of Plant and Pierce. Of these sixteen, two normal adult females were used as controls. Six were killed after a single dose of 50 mg. of morphine sulfate per kilogram of body weight, four of them four hours after the administration of the morphine and two twenty-four hours after. Eight dogs were addicts and had been receiving morphine daily for from one thousand to one thousand, seven hundred and sixty-five days, most of the time in a dose of 50 mg. per kilogram of body weight. They were also killed at intervals of from four to twenty-four hours after the final daily dose, with the exception of two, which were killed during the second day of withdrawal of the drug.

Twenty-eight of the group were young dogs, which were selected from nine litters and raised in our own kennels. The experiments on these dogs were conducted by one of us (A. R. B.) in a separate laboratory. Eight dogs selected from the various litters were used as controls and ranged from 36 hours to 9 months of age when killed. Both sexes were included in the controls and in the experimental animals. No difference was noted in the animals on the basis of age or sex, except that in the younger animals the Golgi apparatus and the mitochondria were more easily demonstrated.

Sixteen dogs from this series, ranging from 12 days to 5 months of age, were used for experiments on acute morphine poisoning. For the experiments on addiction four dogs were used, three of them being from the same litter; a control was also taken from this same litter. Before weaning all five were immunized against distemper. The administration of morphine was started at the age of 1 month, morphine sulfate being used throughout. The drug was injected subcutaneously in a 10 per cent solution, prepared in hot distilled water just before injection. The injections were given daily at 5 p. m., so as to interfere as little as possible with the normal daily exercise and feeding. The initial dose was 5 mg. per kilogram of body weight. The dose was increased at short intervals, finally reaching a level of 50 mg. per kilogram of body weight at the end of three months; it was maintained at this level until the dogs were killed, at from 6 to 9 months of age. The dogs were weighed daily, and the dose of morphine was adjusted to the increase in weight.

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5. Horning, E. S.: Cytopathological Studies of Morphine Poisoning and Chronic Morphinism in the Albino Rat, with Reference to Subsequent Lecithin Treatment, Am. J. Path. **10**:219 (March) 1934.

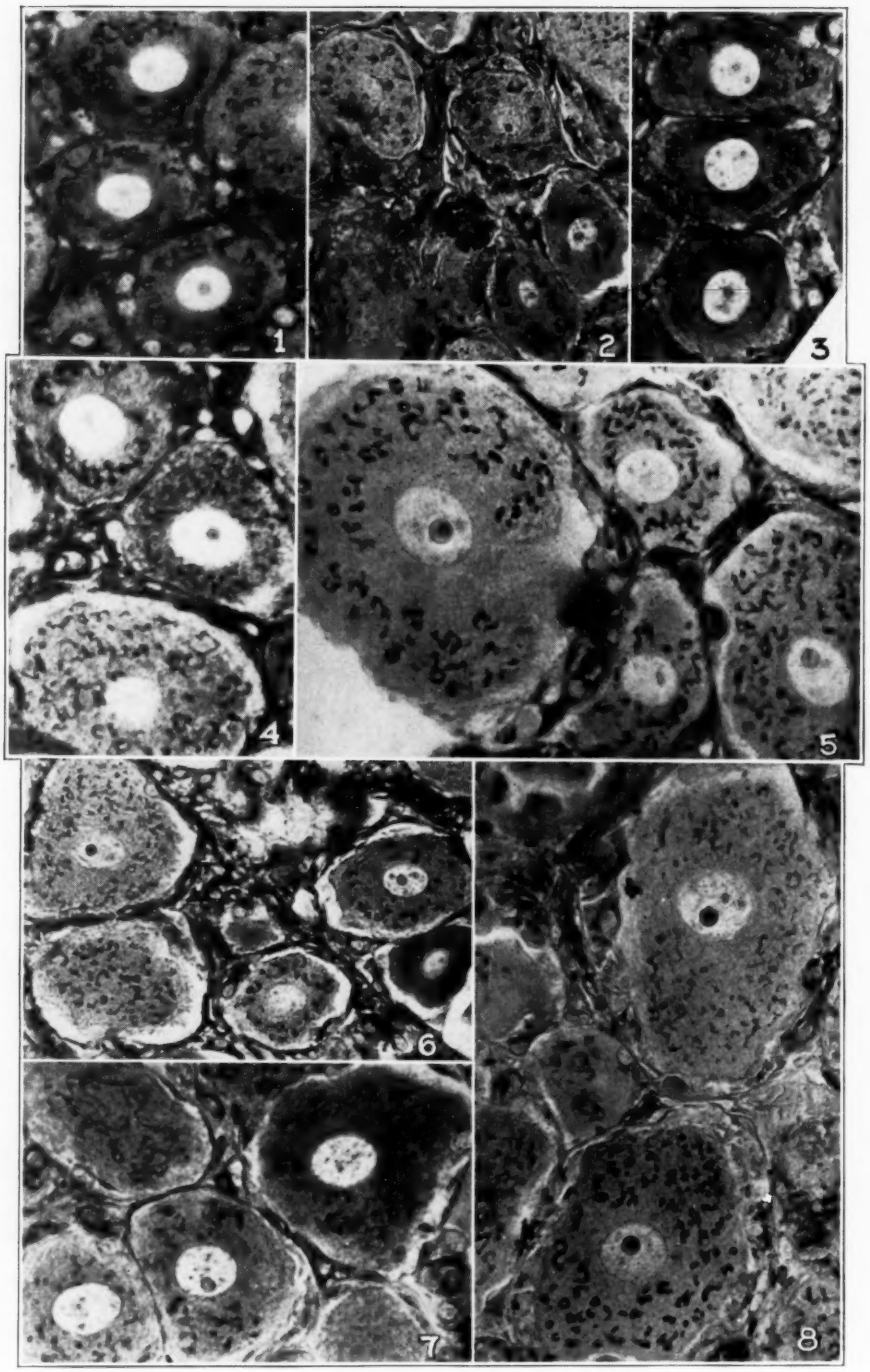

PLATE I

EXPLANATION OF PLATE

Figures 1, 2, 3 and 4 are photomicrographs of cells of posterior root ganglia of four normal dogs. Note the variations in arrangement and in staining reaction of the Golgi material.

Figure 5 shows cells of a posterior root ganglion of a dog which was killed four hours after a single dose of morphine. Compare the Golgi material in the small cells in this figure with those of a normal dog, shown in figure 1.

Figure 6 shows ganglion cells of a dog which was given morphine daily for six months and was killed four hours after the last injection.

Figure 7 shows cells of a posterior root ganglion of a dog which was given morphine daily for eight months. The dog was killed forty-two hours after the last injection.

Figure 8 shows cells of a dorsal root ganglion of a dog which was killed twenty-four hours after a single dose of morphine. The Golgi material in one of the two large cells is much more deeply stained than that of the other.

The adult dogs were killed by bleeding under light ether anesthesia; the pups, by bleeding under chloroform anesthesia. Neither anesthetic produced demonstrable cytologic changes in the tissues examined. For both the pups with acute morphinism and those with chronic morphinism, the same interval of time was allowed to elapse after the final dose before the animals were killed as in the case of adult dogs from the previous series.

Tissues from each animal were fixed by the proper methods for the demonstration of Nissl bodies, neurofibrils, mitochondria and the Golgi apparatus. For the Nissl bodies, tissues were fixed in 95 per cent alcohol plus acetic acid, and the sections were stained with carbol thionine. For neurofibrils, the pyridine silver method of Ranson was used. Mitochondria were demonstrated by the Regaud, Cowdry, Bensley and Severinghaus methods. A combination of the Regaud fixation followed by the staining method of Severinghaus gave excellent results if the sections were treated with 0.125 per cent potassium permanganate and 1 per cent oxalic acid before staining with the aniline fuchsin. For the Golgi apparatus both the osmic acid and the silver technic were used on all tissues. For all the tissues the Mann-Kopsch method, Nassanov's modification of the Kolatchev method and Da Fano's cobalt silver nitrate method were used. All gave satisfactory results in the posterior root ganglia. Da Fano's method after fixation in the refrigerator gave the best results in all other tissues.

CYTOLOGIC OBSERVATIONS

Nissl Substance.—Since the discovery of the Nissl granules many attempts have been made to classify spinal ganglion cells on the basis of these granules. Lugaro,[6] Orr and Rows,[7] Clark [8] and others have attempted a scientific classification on the basis of the size and shape of the cells and the size and distribution of the granules. No two are in exact agreement.

The Nissl granules are modified by the various methods of treatment of the nerve tissues; moreover, even in a single section apparently similar cells show modifications. Although no classification is satisfactory, we have used the paper by Clark [8] for comparison, since he also used dogs and the technic was similar. Counts were made of 1,000 cells from each ganglion. All the types described by Clark were identified in tissue from animals in all the stages of morphinism and in tissue from the controls. No significant difference was found in the percentage of each type in our count. Cells from the anterior horn of the spinal cord, from the motor nuclei of the brain stem, from the cerebral cortex and from the cerebellum were studied. Measurements were made of cells and nuclei of all animals, but no significant differences were noted. No distortion of the nucleus was observed.

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6. Lugaro, E.: Sulla struttura delle cellule dei gangli spinali nel cane, Riv. di pat. nerv. **3**:433 (Oct.) 1898.

7. Orr, D., and Rows, R. G.: The Nerve Cells of the Human Posterior Root Ganglia, and Their Changes in General Paralysis of the Insane, Brain **24**:286 1901.

8. Clark, S. L.: Nissl Granules of Primary Afferent Neurones, J. Comp. Neurol. **41**:423 (Aug.) 1926.

Tissues from each animal were fixed for the demonstration of neurofibrils. No changes were observed in cells from any part of the nervous system.

In the experiments of Ma,[4] the major changes were found in the Golgi lipoid. Figures 1, 2, 3 and 4 show the typical patterns observed in our control dogs. Representative cells of dogs in various stages of morphinism are shown in figures 5, 6, 7 and 8. In none of the sections from our morphinized animals were we able to find any variations morphologically or quantitatively in the Golgi apparatus which could not be duplicated in sections from the control series. It can be seen by referring to figures 1, 2, 3 and 4 that the cells of normal animals, treated identically, show marked variations in the arrangement and staining reaction of the Golgi lipoid.

The same was found to be true for mitochondria, which corresponded with those described by Cowdry [9] and others. No significant differences were observed between the cells of morphinized animals and those of the control animals.

SUMMARY AND CONCLUSIONS

A large series of dogs, including both sexes and ranging from 12 days to several years of age, was used in this investigation. The dogs were subjected to varying degrees of acute and chronic morphine poisoning.

Cells from all parts of the nervous system were studied. No alterations were found in the Nissl substance, neurofibrils, mitochondria or Golgi material which could be definitely set down as an effect of the administration of morphine.

Our findings in dogs do not agree with Ma's observations on the cells of morphinized rats. Not only were we unable to find definite histologic changes which were constant for the varying degrees of morphinism, as he did, but we were unable to find significant variations from the normal in any of our morphinized animals.

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9. Cowdry, E. V.: The Comparative Distribution of Mitochondria in the Spinal Ganglion Cells of Vertebrates, Am. J. Anat. **17**:1 (Nov.) 1914.

ANGIO-ARCHITECTURE OF THE SUBSTANTIA NIGRA AND ITS PATHOGENIC SIGNIFICANCE

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The significance of the cerebral vascular system as an aid in the interpretation of the pathogenesis of disease of the central nervous system is beginning to be more fully appreciated. Recently it has been particularly emphasized by the studies of Cobb,[1] Pfeifer,[2] Putnam [3] and Spielmeyer.[4] From the serial cerebral angio-architectonic preparations of Pfeifer [5] one can visualize and study for the first time the complete vascular bed of the brain. It is obvious from these preparations that knowledge of the cerebral angio-architecture is incomplete. Without knowledge of this one cannot expect to interpret neuropathologic processes fully in the light of the vascular system. The present work is a further step in this direction, limited to the angio-architecture of the substantia nigra. The studies were made from preparations [5] of the monkey and cat into which a contrast medium had been injected.

The arterial blood of the substantia nigra is supplied by branches from four pial arteries (fig. 1): 1. The basilar artery, where it terminates to divide into the posterior cerebral arteries, gives rise to small branches which penetrate the brain stem as paramedial vessels and as interpeduncular vessels (fig. 1, *A*). Some of these vessels supply the most medial-caudal part of the substantia nigra. 2. The posterior cerebral artery, for a distance of 3 mm. from its origin, gives rise to two or three small branches (fig. 1, *B*) which pass upward into the

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1. Cobb, Stanley: The Cerebrospinal Blood Vessels, in Penfield, Wilder: Cytology and Cellular Pathology of the Nervous System, New York, Paul B. Hoeber, Inc., 1932, vol. 2, p. 577.

2. Pfeifer, R. A.: Kreislauf und Hirntuberkulose: Untersuchung zur Pathoangioarchitektonik der entzündlichen Hirnkrankheiten, Dresden, Theodor Steinkopff, 1935.

3. Putnam, Tracy J.: The Pathogenesis of Multiple Sclerosis: A Possible Vascular Factor, New England J. Med. **209**:786 (Oct. 19) 1933.

4. Spielmeyer, W.: Histopathologie des Nervensystems, Berlin, Julius Springer, 1922.

5. Pfeifer, R. A.: Grundlegende Untersuchungen für die Angioarchitektonik des menschlichen Gehirns, Berlin, Julius Springer, 1930.

Fig. 1.—The base of a human brain, showing the pial arteries which supply blood to the substantia nigra. *A* indicates the interpeduncular branches from the basilar artery; *B*, the interpeduncular branches from the posterior cerebral artery; *C*, C_1 and C_2, the larger branches from the posterior cerebral artery; *D*, branches from the posterior communicating artery, and *E*, branches of the choroid artery. Branches indicated by *A*, *B*, *C*, *D* and *E* supply blood to the substantia nigra.

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interpeduncular fossae to supply the medial-caudal part of the nucleus. For a distance of 2 cm. lateral to these arise three or four larger branches (fig. 1, C, C_1 and C_2) which pass laterally and posteriorly along the surface of the basal peduncles. From these arteries arise branches which penetrate the peduncles to supply the lateral two thirds of the substantia nigra. These vessels make up the major blood supply of this nucleus. 3. From the posterior communicating artery arise branches, two or three of which penetrate the cerebral peduncles (fig. 1, D) supplying the medial-superior portion of this area of gray matter. 4. The choroid artery, as it courses along the optic tract, gives rise to several

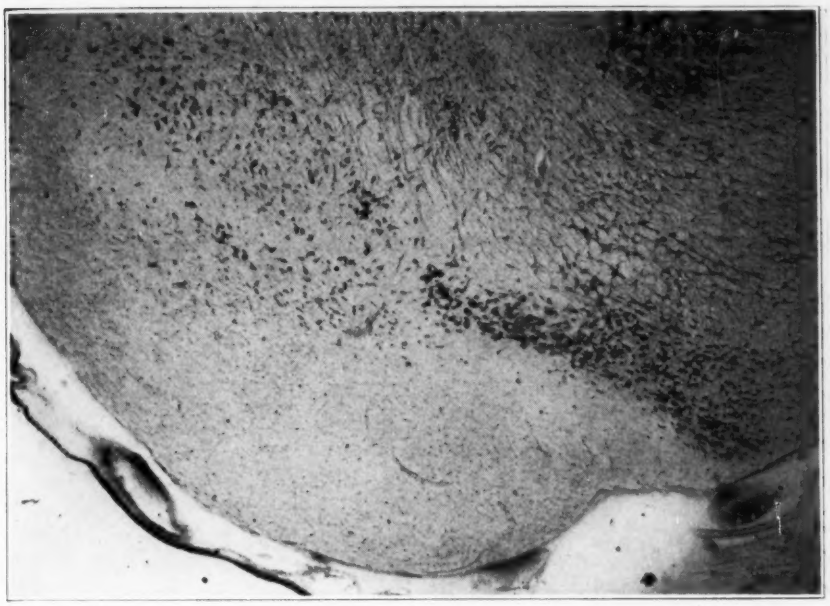

Fig. 2.—Horizontal section (× 19) through the substantia nigra of a cat. Compare with figure 3. In the right lower quadrant is the compact zone. In the left upper quadrant is the more widespread reticular zone. The red nucleus is seen in the upper right corner. Nissl stain.

small branches (fig. 1, E) which penetrate the superior border of the basal peduncle to supply the most medial-superior part of the substantia nigra.

ANATOMY

The substantia nigra, a part of the midbrain, lies in the concave hollow of the cerebral peduncle. Medially and posteriorly it is bordered by the medial lemniscus and the lateral capsule of the red nucleus. In an inferior-superior direction it extends from the pons to the hypothalamus. The substantia nigra is divided into two parts, (1) the com-

pact zone, with ganglion cells lying relatively close together, the latter, in man, containing pigment; (2) a larger reticular zone, with less compact ganglion cells lying among a thicker network of nerve fibers than in the compact zone (fig. 2).

THE ANGIO-ARCHITECTURE WITHIN THE SUBSTANTIA NIGRA

Figures 2 and 3 are cyto-architectural and angio-architectural preparations, respectively, sectioned horizontally through the same level of the substantia nigra in the cat. The descriptions of the illustrations are self-explanatory.

Fig. 3.—Angio-architecture of the substantia nigra in the cat (× 22) the same level as figure 2. Notice the thick capillary bed of the compact zone and the loose capillary network of the reticular zone. (The gray background in the basal peduncles and the right upper field is light refraction due to thickness of the section [100 microns] and should not be confused with capillaries.)

Arteries.—For the characteristic differences between the arteries and the veins the reader is referred to Pfeifer's researches on the angio-architecture of the human brain.[5] The arteries of the substantia nigra may be divided into three groups: (1) those which pass through it, giving up branches on the way; (2) those the terminal branches of which end in the substantia nigra; and (3) those which border it and give up branches which pass into the nucleus from the periphery. The vessels of the first group are the largest and most numerous and sup-

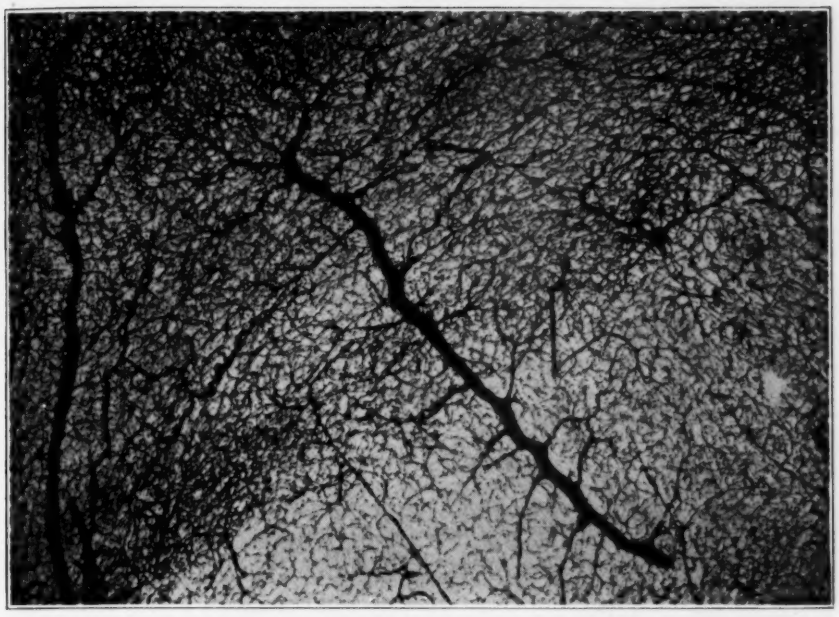

Fig. 4.—Angio-architecture of a small area of the substantia nigra from a monkey (× 30). Running diagonally from the left lower field to the right upper field is the dense capillary bed of the compact zone. In the right lower field is the reticular zone. Passing upward from right to left is an artery giving up branches to both zones of the substantia nigra and terminating in the red nucleus (upper left corner). The denser capillary bed of the red nucleus as compared with the compact zone of the substantia nigra can be seen.

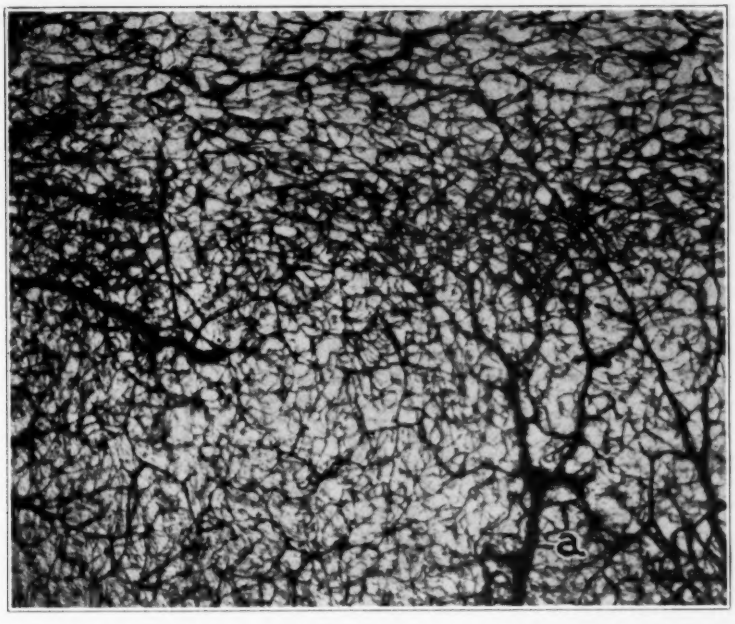

Fig. 5.—Angio-architecture of a small area of the substantia nigra in the monkey (× 40). In the right lower field is seen an artery (*a*) passing through the reticular zone. Its terminal branches disappear into the capillary region of the compact zone.

ply the major part of the blood. They arise mainly from the branches of the posterior cerebral artery, passing directly through the peduncle and the substantia nigra, giving up branches here and terminating in the midbrain and often in the red nucleus or the oculomotor nuclei. In figure 4 is shown such a vessel, a large artery passing upward from right to left, giving off branches in the reticular and compact zones and terminating in the red nucleus. The second group of arteries arise from the pial vessels, passing through the peduncle to terminate in the substantia nigra, usually in the compact zone. An artery of this group is designated *a* in figure 5. Its terminal branches are plainly seen ending in the

Fig. 6.—Angio-architecture through the midbrain of a monkey, showing the substantia nigra (× 16). The dense capillary band of the compact zone is easily distinguished from the reticular zone, the latter lying between the former and the basal peduncle. The vessel marked *A* is an artery of the third group which, in immediate adjacent serial sections, has branches that can be followed into the substantia nigra.

compact zone. These vessels are few and usually are found in the inferior part of the substantia nigra, caudal to the level of the red nucleus. An example of the third group of arteries is the large vessel shown in the upper left corner of figure 6. The vessel lies just posterior to the substantia nigra as the former passes into the roof of the midbrain. In the serial sections, immediately beneath and above this section are branches of this vessel extending into the substantia nigra. The

paramedial arteries (arteries lying adjacent to the median raphe) also give off a few branches which pass into the substantia nigra. The outgoing fibers of the oculomotor nerve, however, form a barrier between these vessels and the substantia nigra, so that no branches of significance are seen at the level of the outgoing fibers of the third cranial nerve.

Capillaries.—More often than not the density of the capillary network in the brain parallels the density of the nerve cells in any given region. This holds true also within the substantia nigra. The capillary network in the compact zone is much denser than that in the reticular zone (compare figs. 2 and 3; see also figs. 4 and 6). In the reticular zone, where the nerve cells are found occasionally grouped, there is also

Fig. 7.—Angio-architecture of the substantia nigra in a monkey (× 17) through the level of the body of Luys (*L*) and the oculomotor nuclei (*O.N.*). To the right of and extending down from the dense capillary bed of the body of Luys (*L*) is the less dense capillary band of the compact zone. Between the body of Luys and the compact zone above and the basal peduncle below is the reticular zone. In the right upper corner is the capillary bed of the oculomotor nuclei, also more dense than that of the compact zone in the substantia nigra. V_1 indicates the vein arising in the body of Luys and passing to the pia through the reticular zone; V_2, the vein arising in the compact zone and passing through the reticular zone to the pia; V_3, the vein arising in the reticular zone.

a corresponding increase in the number of capillaries. In the compact substance the capillaries frequently have an "S" shape as they lie curved between the numerous ganglion cells. In contrast, the capillaries in

the reticular zone form a more loose reticular network in the white substance. A second outstanding difference between the capillaries of the two regions is the short distance between artery and vein in the compact zone as compared with that distance in the reticular zone. In other words, there is a quicker conversion from artery to vein in the former than in the latter zone.

Veins.—The veins, like the arteries, may be divided into three groups. The first, those which originate in some other regions of the midbrain and pass through the substantia nigra, are relatively infrequent. This group is small in contrast to the same type of artery, which was the most frequent. In only the lateral superior part of the substantia nigra, where it lies ventral-medial to the body of Luys, are these veins frequent. In figure *7*, V_1 is shown such a vein, arising in Luys' body and passing out through the reticular substance. Here they originate in the body of Luys and pass through the substantia nigra to the subarachnoid space. The second group of veins, i. e., those originating in the substantia nigra and passing directly out to the subarachnoid space, are the most numerous. Here, again, in direct contrast to the arteries, these veins are the most numerous. They drain the major part of the blood from the substantia nigra. In figure *7* are shown two such veins (V_2 and V_3). V_2 arises in the compact zone, which is the more frequent, and V_3 arises in the reticular zone. The third group of veins, those bordering the substantia nigra and receiving branches from it, for the most part parallel arteries of the same group.

COMMENT

In the literature there is little concerning the blood supply of this region of pigmented ganglion cells. Foix and Nicolesco [6] described it as supplied from the posterior cerebral artery and the anterior choroid artery. Their statement was apparently based on Duret's [7] study of the vascular system by means of injection.

The angio-architecture of the substantia nigra as well as that of other parts of the brain is significant from the anatomic, physiologic and pathologic standpoints.

Anatomically, one of the most interesting points is that the arterial and the venous supply do not parallel one another. Most of the arterial blood reaches the substantia nigra through arteries which pass through it and which terminate in other regions of the brain stem. On the other hand, veins draining blood from the substantia nigra originate there and, without receiving blood from other nuclei, pass directly through

6. Foix, C., and Nicolesco, J.: Anatomie cérébrale des noyaux gris centraux et region mésencephalo-sous-optique, Paris, Masson & Cie, 1925.

7. Duret, H.: Recherches anatomiques sur la circulation de l'encéphale, Arch. de physiol. norm. et path. **6**:60 and 316, 1874.

the peduncles into the subarachnoid space. Most of the arteries are relatively large and the veins small. This lack of parallelism between arterial and venous supply exists also in the association fields of the cortex.[8] That end-arteries of the brain do not exist has been demonstrated by the studies of Cobb[9] and Pfeifer.[5] The present work also bears out their findings, there being no end-arteries in the substantia nigra. Most of the arteries giving off branches here also supply other regions of the midbrain. True, the branches of the second group of arteries mentioned terminate in it. They are not end-arteries, for their terminal branches anastomose with branches of other arteries. A pure experimental syndrome of the substantia nigra, produced by interfering with the arterial blood supply, is clearly impossible because neighboring nuclei would also be involved.

It was pointed out also that within the substantia nigra the density of the capillary network is proportionate to the number of ganglion cells. The number of capillaries is influenced by the demands which the parenchymal elements make on the blood stream. From a physiologic standpoint it is enlightening to compare the relative density of capillaries (with respect to ganglion cells) here with other masses of gray matter. In sections of equal thickness stained by the Nissl method the number of ganglion cells in the body of Luys is definitely less than, for instance, that in the compact zone of the substantia nigra As is evident in figure 7, the density of capillaries in the former is greater than in the latter. This points to a more active metabolism of the ganglion cells in the body of Luys than in the compact zone of its neighbor. On this basis, the nerve cells of the red nucleus, oculomotor nuclei and, undoubtedly, other nuclei, have a more active metabolism also than those in the substantia nigra. However, the latter is not the most poorly vascularized area of gray matter in the brain. The thick cell band of the dentate gyrus is known to have fewer capillaries than even the adjacent white substance of Sommer's sector.[5] It is also not so well vascularized as the substantia nigra. It would appear that, in comparison with most ganglion cell regions of the central nervous system, the nerve cells of the substantia nigra are relatively poorly supplied with capillaries.

Spielmeyer stressed the vascular system as an important factor in the pathogenesis of disease of the central nervous system.[10] It is known that certain regions of the brain are vulnerable to certain disease processes because of regional difference in its blood supply. Sclerosis of

8. Pfeifer: Personal communication to the author.

9. Cobb, Stanley: The Cerebral Circulation: XIII. The Question of "End-Arteries" of the Brain and the Mechanism of Infarction, Arch. Neurol. & Psychiat. **25**:273 (Feb.) 1931.

10. Spielmeyer, W.: The Significance of Local Factors for Electivity in Central Nervous System Disease Processes, Medicine **10**:243, 1931.

the cornu ammonis is a well known example. Putnam [11] recently called attention to the rôle played by the veins in infectious encephalitis and in multiple and disseminated sclerosis. The distribution of the perivascular lesions of the exanthematous encephalitides, as being dependent on the variability in venous distribution and types of veins throughout the central nervous system, has also recently been pointed out.[12] In three cases of measles and postvaccinal encephalitis in which the substantia nigra was studied, perivenous lesions were few. When one notes that these perivenous lesions are most striking about the veins (in contrast to venules), particularly the larger ones, the reason for the limited involvement of the substantia nigra becomes clear. It contains few large veins. As was pointed out, many of the veins originate in the area of gray matter itself, and they reach no significant size until the small branches have converged to form a larger venous stem in the basal peduncle (fig. 7). In neuropathologic conditions, in which the veins are the point of predilection, the rate of blood flow has been suggested as an influential factor in determining which veins shall be involved.[13]

Pfeifer believed that the rate of venous blood flow leaves its stamp on the structure of the veins. Some veins of the brain are characterized by their irregular course, uneven lumen with ballooning and acute angles at which the branches join the main stem. Such veins indicate a sluggish blood flow. Other cerebral veins take on more the characteristics of arteries. The lumen is even, without ballooning. The increase in its caliber is gradual. Branches come in at a less acute angle. These veins have a rapid rate of blood flow and are the type most frequently encountered in the substantia nigra. Putnam [11] has pointed out the significance of thrombosis in multiple and disseminated sclerosis. Slow blood flow is known to be a predisposing factor in thrombosis. In this connection it is interesting that the substantia nigra is one of the less frequently involved regions in the two last-mentioned maladies. Its infrequent involvement in these conditions may be explained, then, on the basis of the type of vein draining its blood.

As the substantia nigra is one of the most vulnerable points in epidemic encephalitis, the question arises if this vulnerability can be explained on a vascular basis. At present this cannot be answered because of limited knowledge of the angio-architecture of other particularly vulnerable regions in this disease, i. e., the oculomotor nuclei

11. Putnam, Tracy J.: Studies in Multiple Sclerosis: IV. "Encephalitis" and Sclerotic Plaques Produced by Venular Obstruction, Arch. Neurol. & Psychiat. **33**:929 (May) 1935.

12. Finley, Knox H.: Significance of Perivenous Anatomic Changes Present in Acute Encephalitides Associated with Vaccination, Variola and Measles, Arch. Neurol. & Psychiat., to be published.

13. Putnam.[11] Finley.[12]

and the hypothalamus. If the vascular system does account for the distribution of lesions, one would expect to find an angio-architectural peculiarity common to all vulnerable regions. One can rule out the veins as playing a major rôle in the pathogenesis of epidemic encephalitis, because the distribution and character of lesions is different from those in conditions in which the cerebral veins do play an important part.

SUMMARY AND CONCLUSIONS

The substantia nigra is supplied by blood from four pial arteries: (1) the basilar artery, (2) the posterior cerebral artery, (3) the posterior communicating artery and (4) the choroid artery.

The angio-architecture of the arteries, capillaries and veins within the substantia nigra is described.

As in other parts of the brain thus far studied, there are no end-arteries.

Most of the parenchymal arteries (as distinguished from pial arteries) supplying the substantia nigra also supply neighboring nuclei. Most of its veins, on the other hand, drain blood only from this nucleus.

Within the substantia nigra the density of the capillaries parallels closely the number of ganglion cells in any given part.

ELECTROMYOGRAPHIC STUDIES OF NEUROMUSCULAR DISORDERS

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CLEVELAND

Numerous electromyographic studies of neuromuscular disorders have been made since 1910. The usual technic employed consisted of placing pad electrodes on the skin over an affected muscle group and leading off the potential changes to a string galvanometer. The electromyograms obtained were useful for indicating gross changes of muscular activity, but little could be done with them by way of analysis of the individual waves. Some investigators measured the frequency and amplitude of each oscillation of the irregular electromyogram, whereas others separated the large and small waves into so-called "primary" and "secondary" waves, which were thought to be of different origin.

During the last few years new methods of recording the small, transient potentials of the body have been developed. Oscillographs have been substituted for string galvanometers of low natural period, and amplification of minute potentials has been made possible. In addition, the work of Adrian and Bronk,[1] Denny-Brown,[2] Eccles and Sherrington,[3] Clark [4] and others has given new information about the organization of the neuromuscular system. For example, the concept of the motor unit (a group of muscle fibers controlled by a single motor neuron) and the fact that a large muscle probably consists of from 200 to 300 or more such units, allows one to interpret the irregular oscillations of the old electromyogram not as "primary" and "secondary" waves of different origin but as the asynchronous discharge of many individual units.

In 1928, Adrian and Bronk [1] developed a technic for recording action potentials from single motor units in an intact human subject

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1. Adrian, E. D., and Bronk, D. W.: J. Physiol. **66**:81, 1928; **67**:119, 1929.

2. Denny-Brown, D.: Proc. Roy. Soc., London, s.B. **103**:321, 1928; **104**: 252, 1929.

3. Eccles, J. C., and Sherrington, C. S.: Proc. Roy. Soc., London, s.B. **106**:326, 1930.

4. Clark, D. A.: J. Physiol. **70**:xviii, 1930; Am. J. Physiol. **96**:296, 1931.

by means of coaxial needle electrodes inserted in a muscle. Adrian,[5] Smith[6] and Lindsley[7] have since described the characteristics of responses of single motor units during voluntary contraction in normal human subjects. Further use of this technic has been made by Lindsley and Curnen[8] in the study of myotonia and by Lindsley[9] in the study of myasthenia gravis.

The present report concerns an investigation of several types of neuromuscular disorders which manifest themselves partly in peripheral phenomena, such as rigidities, spastic states, tremors and other forms of involuntary movement.

APPARATUS AND METHOD

In the majority of cases coaxial needle electrodes were employed, but in a few cases in which this was impossible pad electrodes placed over the surface of the skin were used. The coaxial needle electrodes consisted essentially of a hypodermic needle with a fine insulated wire cemented into its lumen by means of baking varnish. The tip of the central wire was bared and led to the grid of the amplifier; the outside of the needle served as a ground lead.

The electrical potentials were amplified by means of a six stage, transformer-coupled amplifier which drove either a loud speaker for listening to the responses or a Du Bois oscillograph for recording them on moving bromide paper.

Only in certain cases has an attempt been made to record from a single motor unit. In most cases I have been interested in the rhythmic grouping of responses from several units. Unless one takes special precautions with the type of electrodes described, more than one unit in the immediate neighborhood of the surfaces of the electrodes will be recorded from. Electrodes capable of finer isolation of units have been described elsewhere.[7]

The needle electrodes were inserted in the muscle which showed tremors or other involuntary phenomena, no anesthetic of any sort being used, and in most cases the procedure caused no discomfort. The needle electrodes were sterilized by autoclaving and soaking in a 70 per cent solution of alcohol. Rigid tests have shown that with such electrodes there can be no spread of response from neighboring groups of muscles.

When records were to be made of tremors observed in the fingers, the needle electrodes were usually inserted in the flexor digitorum sublimis muscle of the forearm, which is largely responsible for flexion of the middle and ring fingers. The middle finger was attached to a torsion wire myograph (mechanograph), the shadow of the lever falling on the record in such a way that an upward deflection of the myograph line indicated increasing tension. In this way a mechanical record of the tremors was obtained simultaneously with the electrical record. It was the usual practice to record first the resting tremors with the arm supported and the middle finger held lightly against the myograph and then the intention

5. Adrian, E. D.: The Mechanism of Nervous Action, Philadelphia, University of Pennsylvania Press, 1932.

6. Smith, Olive C.: Am. J. Physiol. **108**:629, 1934.

7. Lindsley, D. B.: Am. J. Physiol. **113**:88, 1935; **114**:90, 1935.

8. Lindsley, D. B., and Curnen, E. C.: An Electromyographic Study of Myotonia, Arch. Neurol. & Psychiat. **35**:253 (Feb.) 1936.

9. Lindsley, D. B.: Brain **58**:470, 1935.

tremors during voluntary effort. All records of involuntary activity were supplemented by records of voluntary activity of the same muscle.

REPORT OF CASES

CASE 1.—J. F., a man aged 65, first noticed the onset of tremor in the left arm and leg four years before he came under observation. There was also slight stiffness of the neck. The tremor gradually became worse, and the left arm and leg became stiff. When he was seen there existed a marked tremor of the left arm and a slight one in the right arm. Cog-wheel rigidity was evident on passive flexion of the left arm at the elbow. There were fine tremors of the closed lids and protruded tongue. The gait was slow and shuffling, and slight propulsion to the right was observed. The reflexes were normal except for diminished knee and ankle jerks. The palms of the hands and feet were somewhat cold and clammy, and there was profuse sweating over the entire body.

The diagnosis was paralysis agitans (arteriosclerotic).

CASE 2.—C. K., a woman aged 50, had a marked tremor and some weakness in both hands and arms. Emotional excitement increased the tremor. The face was drawn and lacked expression. Speech had been thick for the past two months and had become weaker. Loss of hair occurred one year before, and little hair remained at the time the patient was seen. She walked with a shuffling gait, and there was some stiffness in the arms. She had been particularly sensitive to cold for six months. The fundi showed definite signs of arteriosclerosis.

The diagnosis was paralysis agitans (arteriosclerotic).

CASE 3.—G. P., a man aged 50, experienced a slight tremor of the right arm and leg two years before. When he was seen there was a slight tremor of the left arm and that of the right arm had grown worse. There was some rigidity of the right leg. The right arm showed a cog-wheel effect on passive movement. There was a typical masklike expression of the face. The patient believed that taste and smell had become somewhat impaired. The reflexes were normal except for diminution of the knee jerks. There was no Babinski sign.

The diagnosis was paralysis agitans (arteriosclerotic).

CASE 4.—N. D., a man aged 55, experienced a tremor of the right hand and dragging of the right foot seven years before. The tremor and rigidity had progressed in severity. When he was seen there was a typical pill-rolling tremor of both hands, more marked on the right side. The tremors were accentuated by fatigue, emotion and worry. The gait was slow and shuffling.

The diagnosis was paralysis agitans (arteriosclerotic).

CASE 5.—J. A., a man aged 35, had tremor of the hands for six years. It started in the fingers of the right hand and progressed until there was shaking of the entire arm and hand. A few months after the appearance of the tremor in the right hand rigidity developed in the right leg, causing it to be dragged. Three years before the patient was seen tremor of the left hand appeared and difficulty in speaking began. The tremor disappeared during sleep and when the fist was clenched, but it reappeared, even though grasp was maintained. Excitement increased the tremor. There were a masklike expression of the face, drooling, exophthalmos, tremor of the lids, lid lag and lack of convergence. Three years before the onset of the disorder the patient had high fever during an attack of grip. He had been exposed to mercury for several years before the onset of the disorder.

The diagnosis was paralysis agitans (probably encephalitic).

CASE 6.—S. M., a woman aged 27, had acute encephalitis in 1922. In 1929 a slight tremor of the tongue began; it became marked in 1931. In 1932 a tremor appeared in the left leg. When the patient was seen she had a parkinsonian type of pseudobulbar speech, a fixed expression, drooling, poorly reacting pupils and rigidity and tremor of the left arm. The left leg was stiff and hard to control. The knee and ankle reflexes were present, and there was no Babinski sign. There were nystagmus on the left and a slight inward rotation.

The diagnosis was paralysis agitans (postencephalitic).

CASE 7.—C. K., a man aged 23, had acute encephalitis at the age of 10. After this there developed a slight tremor of the right arm. The patient fell on his head shortly afterward, and the tremor of the arm became worse and dragging of the right leg appeared. There was also a generalized tremor of the right side. Speech had become affected during the last three years. There was increased sweating around the face and head, and the tremors of the right arm and leg had become worse. The tremors decreased during sleep and sometimes disappeared. The tremor of the right arm was exaggerated when the arm was used. There was loss of associated movements on the right side. The deep reflexes on the right were slightly diminished.

The diagnosis was paralysis agitans (postencephalitic).

CASE 8.—G. S., a man aged 32, was injured in a motorcycle accident in 1929 and about one month later began to have a fine tremor of the left hand; this was more marked when the hand was at rest, and it stopped when the hand was used. There had been no marked increase in the tremor since the end of the first two or three months. Examination on March 7, 1935, showed a marked rhythmic tremor of the right hand when at rest, which was partially controlled on intention.

The diagnosis was monoplegic paralysis agitans (traumatic encephalopathy).

CASE 9.—M. C., a woman aged 32, complained of spells of trembling and numbness for fifteen years. The spells were sometimes preceded by sensations of hunger in the stomach. The tremors occurred chiefly when the hands were used, but they were also present during rest. Both resting and intention tremors were more marked on the left side. There was loss of associated movements on the left in walking. Some vasomotor instability was present. The deep reflexes were hyperactive. A questionable Babinski sign and Oppenheim sign were present on the left. There was a central scotoma on the right, but no other visual disturbances. Speech and gait were not affected.

The diagnosis was multiple sclerosis.

CASE 10.—J. S., a man aged 41, who was depressed, had hypochondriacal ideas and symptoms and constantly felt weak and fatigued. He often staggered and had a sense of falling, though an actual fall did not occur. He had obsessional thoughts of fear and suicide. There was generalized weakness in all the muscles. There were resting and intention tremors of the hand. It was found that the patient had stored up bromide on a normal daily dosage during the past few years; the bromide content of the blood was 350 mg. per hundred cubic centimeters. When this was reduced to a level of 100 mg., strength improved and the mental symptoms disappeared, except for depression. The tremors were reduced.

The diagnosis was psychasthenia with bromide poisoning.

CASE 11.—W. O., a man aged 45, stated that his right leg had become slightly spastic after he was injured in an airplane accident in 1918. After he suffered an acute infection three years before coming under observation the spasticity

became worse, and a tremor of the leg developed. The leg became painful and tender and was slightly rotated inward. The tremors and tenseness were largely in the quadriceps and hamstring groups of muscles, but the flexor digitorum longus and peroneus longus muscles were also involved. The spasticity and tremor disappeared when the patient was under deep anesthesia but returned again before consciousness was regained. Encephalograms showed no evidence of atrophy of the premotor area.

The diagnosis was spastic athetosis.

Case 12.—M. R., a man aged 36, had had involuntary movements of athetoid character in the left arm and hand since the age of 2 years. The condition had been progressive, becoming particularly marked at about the age of 15 and again at 25. When he was seen the speech was impaired, facial muscles were involved and there were some athetoid movements of the left leg. The left hand was continually flexed at the wrist, and there was a coarse shaking of the whole arm. The deltoid, triceps and flexor muscles of the forearm were particularly involved. Alcohol quieted the shaking of the arm, but when the effects wore off the tremor returned with renewed vigor.

The diagnosis was athetosis.

Case 13.—G. C., a girl aged 16, had coarse tremors of the neck, arms and legs three years before she was seen. Her voice had become harsh, and she spoke in a lisping, stumbling fashion. There were occasionally mild seizures during which she stood up, became white and dizzy and sometimes fell. The temporal portion of each optic disk was pale. The patient was unable to move her eyes to the extreme right, and all movements were performed with some difficulty. There was a coarse nystagmus to the left. The trapezius and sternocleidomastoid muscles were weak on both sides. The head was turned slightly toward the right and shook from side to side. The hands and feet were held in a peculiar flexed position. There was marked dysmetria of both extremities, and bilateral adiadokokinesis was present. Sometimes there were body tremors when the patient tried to sit up. The sensory system was normal. The reflexes were hyperactive. There was no familial history of the disorder.

The diagnosis was athetosis and degenerative disease of the basal ganglia.

Case 14.—V. E., a girl aged 13, had had difficulty in walking and talking because of muscular incoordination for eleven years. There was a probability that she had sustained an injury at birth owing to high forceps delivery and some asphyxia. At the age of 1 year she had pneumonia with convulsions. She had convulsions once or twice yearly thereafter until the age of 8 years. When she was seen there were coarse tremors of the head and tongue and choreo-athetoid movements of all four extremities, the disorder being greater on the right side. The tremors became more marked with the onset of menstruation. There was facial weakness on the right side. All involuntary movements were increased under voluntary effort or emotion. Dysmetria and asynergia were present in both hands but were more marked on the right. There was adiadokokinesis on both sides. The sensory system was essentially normal. Babinski, Chaddock and Oppenheim signs were present on the left side, and there was an equivocal plantar response on the right. No ankle jerks were obtained. There was increased palmar sweating. An encephalogram showed a normal cortex but slightly enlarged ventricles. The left ventricle was larger than the right.

The diagnosis was choreo-athetosis affecting both sides.

CASE 15.—M. M., a girl aged 13, whose symptoms appeared three days after birth, suffered considerable injury at birth, and a large hematoma of the scalp was removed surgically shortly after birth. She had never been able to use the right arm extensively because of involuntary movements, and her gait was similarly impaired. The athetoid movements consisted of drawing the right arm backward with the hand and forearm tightly flexed. There was a typical athetoid deformity of the fingers. The athetoid movements of the right leg were less marked than those of the right arm. The right foot was everted and dragged. There was slight atrophy of the right trapezius and infrascapular muscles. There were no sensory disturbances. Both biceps reflexes were absent; the triceps and radial jerks were absent on the right side. The ankle jerk was increased on the right side, and there were positive Chaddock and Oppenheim signs on that side. An encephalogram showed some cerebral atrophy on the left in the arm area of the motor cortex, and there was a questionable atrophy of the thalamus.

The diagnosis was choreo-athetosis.

CASE 16.—I. T., a woman aged 22, had a history of athetoid contractures of the left arm and foot for twenty years. At the age of 2 years she had convulsions lasting three hours; this was followed by the gradual development of the present condition. Six years before she came under observation she began to have frequent attacks of petit mal, and two years later attacks of grand mal developed. For the past two years the attacks had been controlled with phenobarbital. The contracture of the left arm had become worse in recent years. When the left arm was at rest it was acutely flexed at the elbow and wrist. The distal phalanx of the thumb and that of the index finger were hyperextended. The arm and hand were externally rotated. There was some spasm of the flexor muscles of the hand and arm. There was an involuntary grasp reflex on the left side. Involuntary movements of the left hand and arm occurred when the patient used the right hand. The left foot remained constantly in moderate inversion, with the toes hyperextended. The sensory system was normal. A Babinski sign and a Chaddock sign were present on the left side. When the patient was under deep anesthesia the left arm relaxed almost completely, but the usual state of contracture returned before complete consciousness was regained.

The diagnosis was hemiathetosis.

CASE 17.—D. P., a girl aged 18, acquired spastic flexion of the right arm and leg shortly after an attack of diphtheria at 6 years of age. There were marked flexion and some eversion of the foot. The arm and hand were continually flexed. The tendon reflexes were absent on the right side.

The diagnosis was hemiathetosis.

CASE 18.—R. S., a woman aged 20, had a spastic condition of the muscles of the right leg. Four years before she was seen pain developed in the leg, and athetoid spasms of the muscles became worse. The gastrocnemius and the peroneus muscles were particularly affected.

The diagnosis was hemiathetosis.

CASE 19.—R. G., a man aged 48, who had generalized athetoid movements of the entire body, presented almost continuous squirming movements of some part of the body without definite pattern. Facial expression and speech were particularly involved.

The diagnosis was choreo-athetosis.

CASE 20.—A. P., a girl aged 17, had involuntary spasms involving the muscles of the mouth, right arm, shoulder and leg which resulted in extension of both the arm and the leg, with inward rotation. There was slight spasm of the left side,

although most of the involvement was confined to the right. The knee jerk was hyperactive on the right but was normal on the left side. There was no ankle or patellar clonus. There was an equivocal Babinski sign on the right side.

The diagnosis was dystonia musculorum deformans.

CASE 21.—M. L., a man aged 21, presented grotesque grimaces of the face and ataxic and athetoid movements of the left arm and leg. Writing and speech were greatly disturbed. The involuntary contortions were so severe that it was impossible for the patient to move about alone. There were frequent spasms of the muscles of the neck and face.

The diagnosis was dystonia musculorum deformans.

CASE 22.—J. B., a man aged 46, first noticed a twitching of the nose and mouth six years before he was seen. Later twitching of the face and neck developed. Two years before he came under observation quick, jerky movements of the muscles of the arms and shoulders appeared. When he was seen there were lightning-like contractions of the muscles of the shoulders, which caused raising or shrugging of the shoulders. There were similar contractions of the platysma. The abdominal muscles and the diaphragm were involved and caused frequent sniffing reactions. The deep reflexes were brisk but equal. There were no sensory disturbances. The patient was highly irritable and given to outbursts. The immediate family history was irrelevant.

The diagnosis was Huntington's chorea.

CASE 23.—H. B., a woman aged 45, had a background of emotional instability. The head was drawn backward and rotated slightly to the right. The trapezius, splenius, scalenus and cleido-cervicalis-occipitalis muscles were particularly involved. The spasms of the cervical muscles were sustained and caused considerable pain. Nystagmus was produced by rolling the patient from her back to her side. Abnormal reactions to Bárány tests were also observed.

The diagnosis was torticollis with probable labyrinthine involvement.

CASE 24.—I. T., a woman aged 21, first noticed a slight shaking of the head from side to side one year before she was seen; the disorder followed a series of highly emotional situations over which conflicts arose. Shortly afterward the head became rotated to the extreme right, and remained in that position for six months. The left sternocleidomastoid muscle became greatly hypertrophied and painful. Rest in bed, removal from exciting environment and psychotherapy relieved the condition almost entirely.

The diagnosis was torticollis (hysterical).

CASE 25.—M. H., a woman aged 53, whose head was drawn back and rotated toward the right, presented an almost continual clonic jerking of the head backward. The disturbance was more severe in the morning and evening. Five months before the patient was seen the shaking was severe. Remissions had occurred since the onset, six months before. Three weeks before admission the patient had an emotional upset over a minor incident. There was vomiting, and bowel movements occurred from fifteen to twenty times a day. The patient was highly emotional and unstable.

The diagnosis was torticollis (hysterical).

CASE 26.—L. L., a woman aged 32, suffered from headaches and impaired vision three weeks before her admission to the hospital. Two weeks before admission she had amblyopia on entering a lighted room from a dark bedroom. This was accompanied by headache, a feeling of cold and numbness in her feet and legs and inability to move them. She was not able to speak fluently and talked

foolishly when she did. She had amnesia for that day. The torticollis was to the left and was associated with a slight twisting and shaking movement in that direction. The headache was worse on the right side. The right arm was slightly weak. There had been marked attacks of excitement for three months. For the past fourteen years, according to her husband, the patient had been emotionally unstable, often falling on the street in temper tantrums, without losing consciousness.

The diagnosis was torticollis (hysterical?).

CASE 27.—H. K., a man aged 36, had had spasticity of the right leg for fifteen years. When he was examined thirteen years before the electromyographic studies were made there were marked bowing of the back, muscular fibrillation in the right quadriceps muscles, weakness of the biceps, deltoid and triceps muscles on the right side, flabbiness of the muscles of the right arm, with loss of reflexes, and hyperactivity of reflexes on the left. At the time of examination there was a spastic condition in both legs, the disorder being more marked on the right. There was a typical scissors gait. The knee and ankle jerks were hyperactive on both sides, and there was a sustained clonus.

The diagnosis was spastic paraplegia.

CASE 28.—P. P., a boy aged 15, had marked scoliosis and kyphosis. Sensation was diminished in all regions below the seventh rib. There was a small area of complete anesthesia on the right in the region of the seventh rib. There were some atrophy, weakness, spasticity and rigidity in the muscles of the right leg. The knee and ankle reflexes were hyperactive, with bilateral nonsustained clonus and a Babinski sign.

The diagnosis was a spastic state due to compression of the cord.

CASE 29.—C. F., a man aged 53, first noticed weakness of the muscles of the arm two years before he came under observation. When he was seen the weakness had progressed to include both arms and legs. The biceps muscle on the right was markedly atrophied, and that on the left was slightly atrophied. There were bilateral weakness and atrophy of the triceps, tibialis anticus and thenar muscles. The abdominal and cremasteric reflexes and the right biceps jerk were absent.

The diagnosis was progressive muscular atrophy.

CASE 30.—E. K., a man aged 27, first noticed weakness and some loss of control of the thumb and fingers of the right hand. When he was examined weakness had appeared in the left hand also. The muscles of both hands were markedly atrophied, and there was considerable atrophy of the trapezius, sternocleidomastoid and intercostal muscles on the right side. There were twitchings in the fingers of both hands and in the muscles of the abdomen, chest, back and tongue. There was no pain. The gag reflex was absent. The biceps and triceps reflexes were hyperactive. There was a positive Chvostek sign. The Wassermann reaction was negative.

The diagnosis was progressive muscular atrophy.

CASE 31.—J. C., a man aged 64, first noticed weakness of the left arm and hand two years before he came under observation. Weakness appeared in the right hand three months before he was seen. There was difficulty in walking because of the weak atrophied muscles of the girdle. Twitching had been observed in the biceps and triceps and also in the muscles of the forearm. The cranial nerves were normal. There was no atrophy of the shoulder girdle and muscles of the upper part of the arm. The left ankle jerk was absent. There was an equivocal Babinski sign bilaterally.

The diagnosis was progressive muscular atrophy.

CASE 32.—W. H., a man aged 39, had noticed marked weakness and wasting of both arms and legs during the last five years before he came under observation. There were marked atrophy and fibrillation in almost all the muscles except the gastrocnemius muscle and the muscles of the forearms. The deep reflexes were somewhat diminished.

The diagnosis was progressive muscular atrophy.

CASE 33.—C. M., a man aged 56, had noticed a gradual painless weakening of the biceps muscles, which began about fifteen years before he came under observation. The biceps muscles were practically absent. Two years before he was seen considerable weakness and atrophy appeared in the right leg. Twitching was prominent in the muscles of both legs. There was also marked atrophy of the trapezius, rhomboid, pectoralis, sternocleidomastoid and thenar and hypothenar muscles. The knee jerks were absent, but the ankle jerks were present and equal.

The diagnosis was progressive muscular atrophy.

CASE 34.—A. S., a man aged 45, had had weakness and atrophy of the muscles of the left arm and shoulder for two years, the disorder appearing after he sustained an injury to the upper part of the left arm. At operation a hard fibrous mass was found between the fifth and the sixth dorsal vertebra; this was not removed. There was hyperesthesia to touch, pain and temperature over the left biceps muscle and a definite area of the left side of the back. There was decreased sensation to pain on the right side below the level of the fifth cervical vertebra. The right pupil was larger than the left. Sharp pain radiated over the left shoulder. There were positive Chaddock and Hoffmann signs on the left. The deep reflexes were equal on both sides. There was no Babinski sign. There was no fibrillation or spasticity.

The disorder was considered to be due to a lesion of unknown type pressing on the spinothalamic and corticospinal tracts at the level of the fifth and sixth cervical vertebrae.

CASE 35.—E. W., a man aged 62, had had pain in the back, which radiated down the left arm, for one year. The left arm was weak, and there was evidence of atrophy in the muscles of the upper portion of the arm and in the thenar muscles. There was muscular twitching in both arms and on the dorsa of both hands. The patient stated that when he awoke in the morning the left arm felt numb. Often there was a tingling sensation in both arms. The lumbar portion of the spine showed a curve to the left. The reflexes were equal and active.

The diagnosis was tumor of the spinal cord.

CASE 36.—W. K., a man aged 46, noticed that his biceps muscles became weak and wasted four years before he came under observation. Seven months before he was seen the wrists became weak. Six months later he noticed a pricking sensation in the right great toe; at the time of examination the same sensation was present in both legs and feet. There was bilateral wrist drop. All the muscles of both arms and legs were greatly atrophied and flabby. The right biceps consisted of only a fine strand of muscular tissue, so that the patient was unable to flex his arm against gravity. The finger jerks were absent. The knee jerks were hyperactive. The ankle jerk was diminished on the right. There was an equivocal Babinski sign bilaterally. The biceps reflexes were absent on both sides.

The diagnosis was amyotrophic lateral sclerosis.

CASE 37.—J. F., a man aged 40, had had weakness and atrophy of the muscles of the left hand for one year. There were some weakness and atrophy of the

muscles of the forearm and left shoulder. There was fibrillary twitching around the left shoulder and in the left quadriceps muscles. There was a Hoffmann sign bilaterally. The deep reflexes were hyperactive.

The diagnosis was amyotrophic lateral sclerosis.

CASE 38.—O. D., a man aged 32, first noticed pain on the lateral aspect of each leg sixteen years before he came under observation. The ankles and knees became weak. He had influenza fourteen years before he was seen, and after that the weakness increased. There was marked atrophy of all the muscles below the knee, with slight atrophy of the muscles of the lower part of the upper portion of the leg, beginning at a fairly definite ring about 2 inches (5 cm.) above the knee. The patient could not dorsiflex his feet at all, and plantar flexion was weak. There were bilateral foot drop and steppage gait. The knee jerks were hyperactive, and there was poorly sustained patellar clonus. The ankle jerks were absent. There was some vasomotor disturbance. There was diminished vibration sense in the feet. A brother, aged 36, had the same condition.

The diagnosis was peroneal muscular atrophy of the Charcot-Marie-Tooth type.

CASE 39.—E. F., a boy aged 7 years, had generalized atrophy, flaccidity and weakness. There was fibrillary twitching of the muscles of the back, shoulders and fingers.

The diagnosis was poliomyelitis.

RESULTS

I. TREMORS

Paralysis Agitans.—The tremors of eight patients with syndromes of paralysis agitans have been studied. In cases 1, 2, 3 and 4 the disorder was of the senile type, probably resulting from arteriosclerosis. In case 5 the patient presented a typical picture of paralysis agitans, but the cause of the disorder was unknown; it may have been due to chronic encephalitis. In cases 6 and 7 the disorder was of the postencephalitic type, symptoms of paralysis agitans having developed in each case shortly after an attack of acute encephalitis. In case 8 the condition was atypical and apparently resulted from a trauma.

In each of these cases the tremors of the fingers were studied by leading off the action potentials of the flexor digitorum sublimis muscle of the forearm group by means of coaxial needle electrodes inserted in a muscle. The middle finger was attached to the myograph (mechanograph) lever and gave a simultaneous record of the oscillations of the finger.

The electrical responses obtained during the tremors were heard in a loud speaker as definite volleys separated by periods of quiescence. Figure 1*A* shows a typical record obtained in case 1. The action potentials appear in groups just preceding each tremor oscillation, as represented by the upswing of the myograph curve. Each volley consists of several motor unit responses which are not quite synchronous. The rhythmic groupings of responses in this patient were extremely regular and always occurred at a frequency of from 5 to 5.5 per second.

Figure 1*B* shows a record obtained in case 5. Each volley consists of the responses of three motor units which were active in the immediate neighborhood of the electrodes. The tremors with their accompanying electrical responses always occurred regularly in this patient at a frequency of from 4.5 to 5 per second. In figure 1*C* is shown the effect of voluntary effort on the tremors as registered by the mechanical record and the grouping or volleying of the action potentials. The electrical activity appears continuous and irregular, and the myo-

graph curve is flat. There may still be a slight tendency for grouping of the action potentials to persist in this record, but if the intensity of the contraction were increased still more all evidence of the grouping would disappear.

The tremors which persist during voluntary activity (intention tremors) in the patients in this group always maintained the same frequency as those which occurred during rest. As will be seen, this was in contrast to observations of resting and intention tremors in cases 9 and 10.

Figure *2A* shows a record obtained in case 6, in which the tremors always occurred regularly at a frequency of from 6.5 to 7 per second. A typical record made in case 8 is presented in figure *2B*. The frequency of the tremors in this patient was from 5 to 5.5 per second. Figure *2C* shows a record made in case 2,

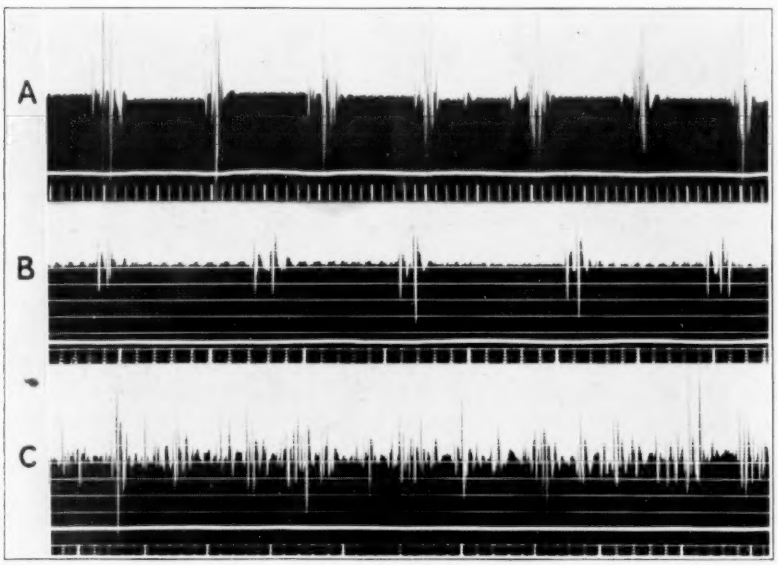

Fig. 1.—Rhythmic groups of action potentials during resting tremors in patients with paralysis agitans. *A*, record of J. F. (case 1). *B*, record of J. A. (case 5). *C*, record from the same muscle of A. J. (case 5) during voluntary contraction. The white line is the myograph record of tension. The time intervals in *A* are twenty milliseconds; in *B* and *C*, twenty-three milliseconds.

in which tremors were regular and occurred at a frequency of from 4 to 4.5 per second. The records made in cases 3, 4 and 7 are similar to the others that have been illustrated, except that the frequencies of the response volleys were, respectively, from 5 to 5.5, from 6 to 7 and from 4.5 to 5 per second.

Records have been obtained from other muscles of each patient, and they have shown the same frequency of action potential groups as were recorded from the flexor digitorum sublimis muscle. For example, the frequency of the tremors from the deltoid muscle in case 7 was exactly the same as that from the flexor digitorum sublimis. In case 5 the frequency of action potential groups was the same in the biceps as in the flexor digitorum sublimis muscle. While tremor responses were recorded in this patient he was asked to try to stop the tremors.

He was able to stop them momentarily by voluntary contraction of the muscles of the arm, but the tremors and their response volleys soon reappeared at the usual frequency.

In any one record each action potential volley consists of the same motor unit responses, although their order may vary considerably. The duration of each volley varies from twenty to eighty milliseconds, depending on the number of motor units from which responses were recorded and on the intensity of the tremors. The intensity of the tremors varied spontaneously from time to time and particularly under excitement or emotion. The average frequency of the tremors for the eight patients was 5.3 per second.

In two of the patients in whom the muscles of the upper portion of the arm showed rigidity, records were obtained from the biceps and triceps muscles during

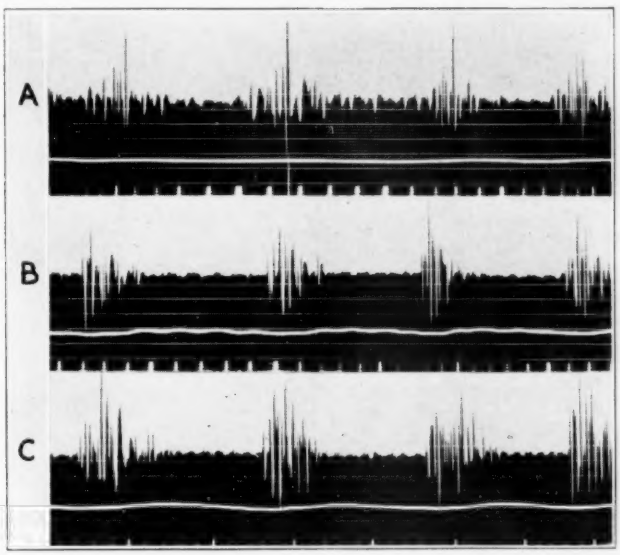

Fig. 2.—Rhythmic groups of action potentials accompanying resting tremors in patients with paralysis agitans. *A*, record of S. M. (case 6); the tremor frequency is 7.0 per second. *B*, record of G. S. (case 8); the tremor frequency is 5.5 per second. *C*, record of C. K. (case 2); the tremor frequency is from 4 to 4.5 per second. The white line is the myograph records of tension. The time intervals in all the records are twenty-three milliseconds.

passive flexion and extension of the arm, which produced a cog-wheel effect. The electrical record showed groups of action potentials similar in frequency and duration to those recorded during tremors.

Records obtained from the flexor digitorum sublimis muscle of a normal subject during attempts to imitate voluntarily the parkinsonian tremor showed less precise and less regular groups of action potentials than were recorded for any of the patients.

Multiple Sclerosis.—In case 9 the disorder was tentatively diagnosed as multiple sclerosis. The tremors of the arms and fingers were not as coarse as those ordinarily seen in cases of paralysis agitans. Figure 3*C* shows a record obtained

from the flexor digitorum sublimis muscle by means of coaxial needle electrodes while the arm was at rest. There are groups of action potentials separated by periods of complete quiescence. The frequency of these response groups is from 5 to 5.5 per second. The record shown in figure 3*D* was obtained with the electrodes in the same position, but while intention tremors were present. The groups of action potentials are larger, and it is apparent that more units are active. The frequency of the intention tremors is from 6.5 to 7 per second, a slight increase over the frequency of the resting tremors in the same muscle.

Bromide Intoxication.—In case 10 also there were fine resting and intention tremors. These seemed to be related to the high bromide content of the blood,

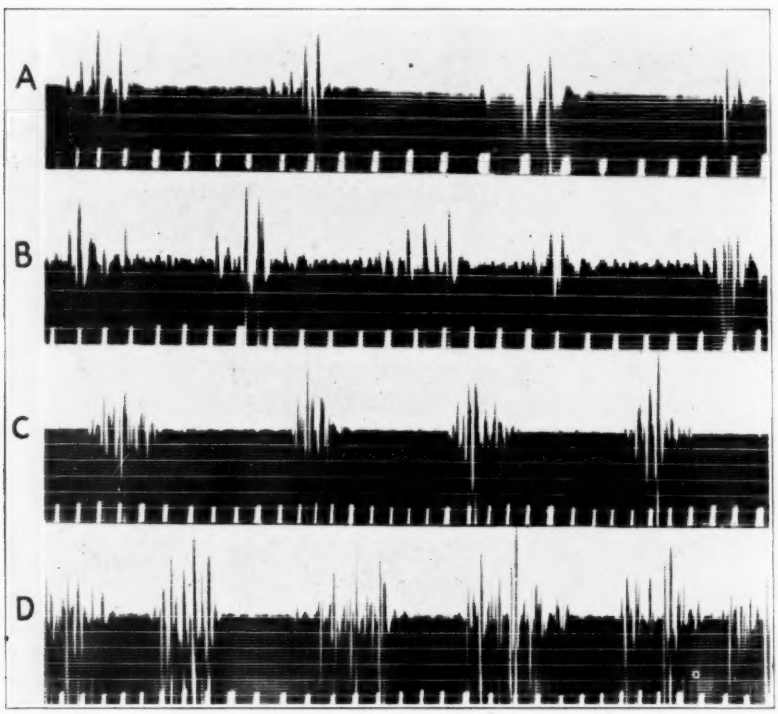

Fig. 3.—Records showing increase in frequency of intention tremors over frequency of resting tremors. *A* and *B*, resting and intention tremors, respectively, in a patient with bromide poisoning (case 10). *C* and *D*, resting and intention tremors, respectively, in a patient with multiple sclerosis (case 9). The time intervals in all the records in this figure are twenty-three milliseconds.

for when this was reduced to normal the tremors as well as some of the other symptoms disappeared. Figures 3*A* and 3*B* show records of the resting and intention tremors, respectively. The volleys of action potentials are not as regular as most of those observed thus far. The frequency of the volleys during the resting tremors ranges from 6.5 to 8 per second, while in records obtained during the intention tremor it ranges from 7.5 to 10 per second.

II. ATHETOID MOVEMENTS

In the cases to be discussed under the heading of athetosis, several types of involuntary activity have been observed. In some cases the involved muscles were almost continually tense or rigid, and slight tremors were occasionally present; in some cases there were slow, squirming movements of the "dystonic" type involving whole groups of muscles; in still other cases series of clonic contractions persisted

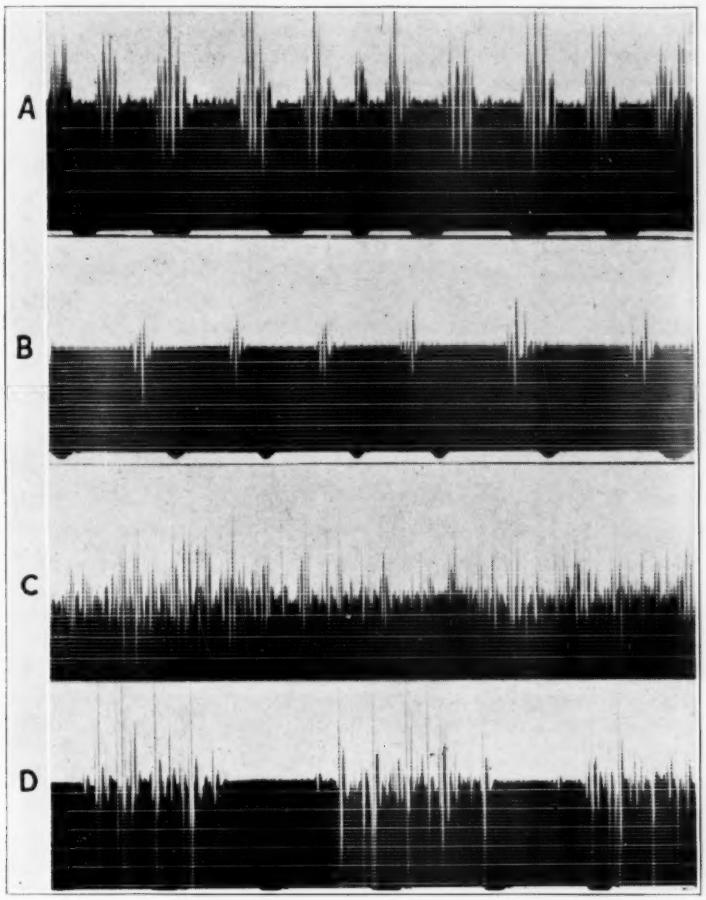

Fig. 4.—*A*, *B* and *C*, action potentials from the rectus femoris muscle of a patient with athetosis (case 11). *A*, record before operation. *B*, record after the first operation; *C*, record made during voluntary contraction before operation. *D*, action potentials from rectus femoris muscle of a normal subject during an attempt to imitate tremors of the patient whose records are shown in *A*, *B* and *C*. The time intervals in all the records in this figure are two hundred milliseconds.

for a few seconds at a time, causing oscillations of a limb. Two or more of these forms of involuntary muscular activity are sometimes combined in a single patient.

Although tremors do not always accompany the types of involuntary movement just mentioned, I have observed from the records that a grouping or volleying

of action potentials is a common feature in all of them. The grouping of responses appears to be similar to that observed during the tremors of paralysis agitans. However, the frequency with which these volleys occur is often a differentiating feature.

Figure 4*A* shows a record obtained from the rigid and somewhat tremulous rectus femoris muscle in case 11. The groups of action potentials are separated by periods of relative quiescence and occur at a frequency of 7 per second. After an operation by Dr. T. J. Putnam, in which unilateral section of the vestibulospinal and reticulospinal tracts in the anterior column was attempted, the rigidity and tremors of the leg were diminished. Voluntary contraction of the involved muscles was also facilitated. Records of action potentials obtained from the rectus femoris muscle after the operation are shown in figure 4*B*. The groups of action potentials are smaller and occur at a frequency of 5 per second. There is also less indication of activity between volleys than may be seen in the original records, although the same amplification was used in obtaining both series of records.

Later an attempt was made to section still more of the tracts of the anterior column. After this second operation the rigidity and tension of the muscles was reduced further, but a slight tremor still persisted. Electromyographic records obtained at this time showed a slight grouping of action potentials, perhaps even less prominent than that shown in figure 4*B*, but at the same frequency.

Before the first operation there had been some question about this condition's being of hysterical nature. At the time figure 4*A* was obtained with the leg at rest, another record, figure 4*C*, was obtained, while the patient voluntarily attempted to contract the rectus femoris muscle. The voluntary effort resulted in continuous, irregular action potentials, without evidence of grouping such as occurred with the leg at rest. The transition from the grouping of the responses with the leg at rest to the continuous activity which accompanied voluntary effort seemed to differentiate two types of response, that presumably originating in involuntary centers and that originating in the cortex or voluntary centers. Furthermore, a record (fig. 4*D*) obtained from the rectus femoris muscle of a normal subject during an attempt to imitate voluntarily the tremors of this patient shows groups of action potentials of much greater duration and lower frequency (from 2 to 2.5 per cent) than those obtained from the patient. These facts, in addition to other considerations, seemed to offer a reasonable basis for assuming the movements to be of extrapyramidal origin.

In case 12 the involuntary movements of the left arm were of the clonic type. For a few seconds at a time the arm would be flopped about in a purposeless fashion and then the movements would subside. During such a series of movements records were obtained from the deltoid, triceps and flexor digitorum sublimis muscles. These records showed groups of action potentials separated by a period of relative inactivity. The groups occurred at frequencies of between 5 and 7 per second but were not quite as rhythmic as those obtained in case 11. Figure 5*A* shows a record obtained from the triceps muscle in case 12 during a series of involuntary movements of the arm. The frequency of the groups is about 5 per second.

The record shown in figure 5*B* was obtained from the tibialis anticus muscle in case 14 during a spastic-like contraction which dorsiflexed the foot. The volleys of action potentials in this record occur at a frequency of about 8 per second.

The involuntary movements in case 20 were of the slow, dystonic type, extending the right arm and leg. During one of these movements the record shown in figure 6 *A* was made from the right triceps muscle. The frequency of the groups of action potentials is between 10 and 11 per second.

Figure 6 *B* was obtained from the left biceps muscle in case 16, in which the hand and forearm were continually held in a flexed position. In this record three motor units are discharged in groups which occur at a frequency of 10 per second. A record (fig. 6 *C*) obtained from the biceps muscle of the right arm, which was apparently normal, shows no evidence of volleys of action potentials. The action potentials occur continuously and appear normal in every way.

In case 15 there were rhythmic flexions and extensions of the fingers and clonic-like contractions of the biceps muscle which maintained the forearm in a flexed position. The involuntary movements were not continuous but occurred

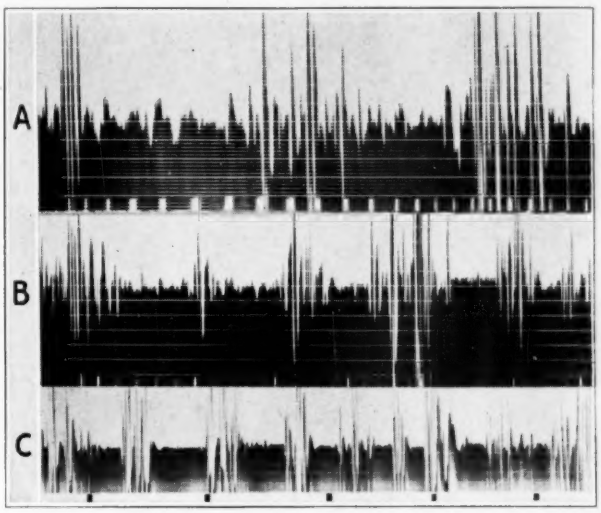

Fig. 5.—*A*, action potentials from the triceps muscle of a patient with athetosis (case 12) during involuntary movements of the arm. *B*, action potentials from the tibialis anticus muscle of a patient with athetosis (case 14) during spastic-like contraction. *C*, rhythmic groups of action potentials from the biceps muscle of a patient during clonic convulsions produced by compression of the carotid arteries. The time intervals in *A* and *B* are twenty milliseconds; in *C*, two hundred milliseconds.

in a series separated by periods during which there was sometimes rigidity of the muscles of the arm and sometimes almost complete relaxation. Records were made from the flexor digitorum sublimis muscle during oscillations of the fingers (fig. 7*A*) and from the biceps muscle during the clonic-like movements of the forearm. In both cases the groups of action potentials occurred at a frequency of about 2 per second. The groups were of long duration but were separated by equally long periods of complete quiescence. During the periods of rigidity the grouping was less obvious and action potentials appeared almost continuously except for brief interruptions about twice a second.

In case 13 there appeared to be widespread lesions of the basal ganglia, for there were coarse tremors of the arms, legs and head in addition to contractures of the muscles of the forearm. While the head was rotated slightly toward the right and was shaking from side to side, a record (fig. 7*B*) was obtained from the left sternocleidomastoid muscle. This record shows almost continual action potentials, except for brief interruptions which seem to occur fairly rhythmically. Arcs have been drawn on the record to indicate this grouping, which occurs at a frequency of about 2 per second.

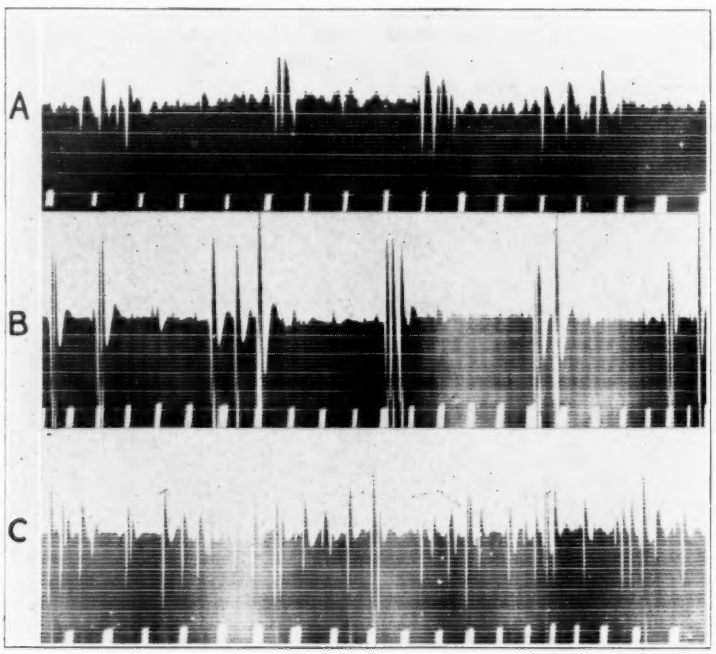

Fig. 6.—*A*, groups of action potentials from the right triceps muscle of a patient with athetosis (case 20) during dystonic movements of the arm. *B*, rhythmic groups of action potentials from the left biceps muscle of a patient with athetosis (case 16) during involuntary contracture. *C*, normal-appearing action potentials from the normal right biceps muscle of a patient with athetosis (case 16). The time intervals in *A* are twenty-three milliseconds; in *B* and *C* they are twenty milliseconds.

In case 18 there were brief spasms of the extensor muscles of the right leg. Records obtained from the gastrocnemius muscle during such athetoid spasms showed definite groups of action potentials with periods of quiescence between them. The groups occurred fairly regularly at a frequency of 10 per second.

The condition in case 17 was similar to that in the preceding case, except that the athetoid spasms involved particularly the peroneus longus and tibialis posticus muscles. The records obtained from these muscles showed groups of action potentials at a frequency of about 10 per second. In both of these cases voluntary activity of the muscles which showed the spasms gave continuous action potentials without evidence of grouping.

In case 19 there were the most widespread and most intense involuntary movements in any of the cases of athetoid movements. Practically all the muscles were involved, although not simultaneously. The movements were coarse and of rather brief duration. Different groups of muscles became spontaneously active in a jerky, choreiform manner. There were tremors of the arms at times during involuntary movements. Records were obtained from the brachioradialis muscle during the tremors of the arm and from the trapezius muscle during the involuntary movements of the head and neck. In both records there were large groups of action potentials separated by periods of complete quiescence. The groups occurred fairly regularly at frequencies of between 4 and 5 per second.

In case 21 there were rather slow, dystonic movements of the left arm and leg as well as of the face and neck. As a result there were bizarre grimaces of the face and slow writhing movements of the head, neck, arm and leg. Records were obtained from the left triceps muscle during an athetoid spasm of the arm.

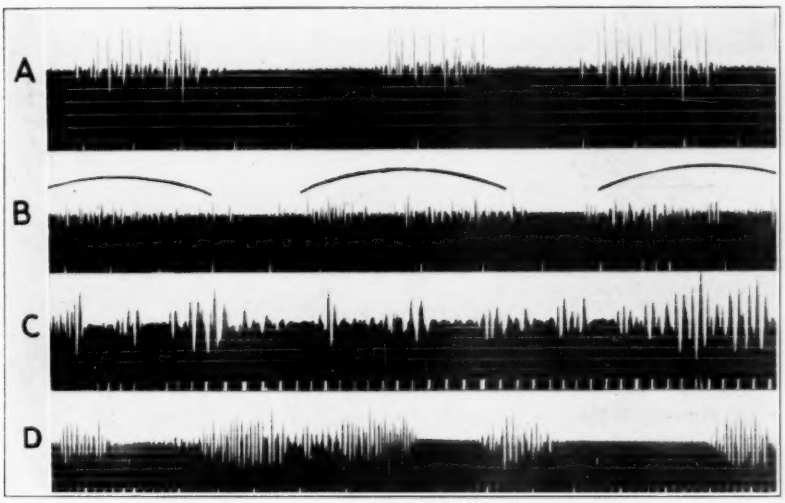

Fig. 7.—*A*, rhythmic groups of action potentials from the flexor digitorum sublimis muscle of a patient with athetosis (case 15) during involuntary flexions and extensions of the fingers. *B*, groups of action potentials from the left sternomastoid muscle of a patient with athetosis (case 13) during rotation and shaking of the head to the right. *C*, arrhythmic groups of action potentials of variable size and duration from the left sternocleidomastoid muscle of a patient with hysterical torticollis (case 24) while the head was rotated to the right. *D*, arrhythmic groups of action potentials of variable size and duration from the right sternocleidomastoid muscles of a patient with hysterical torticollis (case 25) while the head was rotated to the left. The time intervals in *A* and *B* are twenty milliseconds; in *C* and *D* they are twenty-three milliseconds.

There was an apparent grouping of the action potentials at a frequency of from 9 to 10 per second. After a partial transection of the vestibulospinal and reticulospinal tracts in the anterior column by Dr. T. J. Putnam, the severity of the involuntary movements was considerably reduced. Records obtained from the

left biceps muscle during some of the remaining involuntary movements showed a tendency toward a grouping of action potentials at about 10 per second. The grouping was less marked, however, than before the operation.

Because of the possible relationship it may have to the results obtained in the cases thus far reported, the case of a patient in whom artificial convulsions could be produced by pressure on the carotid arteries will be discussed. With the patient in the supine position, the carotid arteries were tightly pressed. The patient became dizzy and soon lost consciousness. The arms and legs flexed in clonic convulsions. A record (fig. 5*C*) was obtained from the biceps muscle just as the patient lost consciousness and the clonic convulsions began. Accompanying each clonic contraction is a group of action potentials. These groups occur at a frequency of approximately 8 per second, which is similar to the frequency of the response groups recorded in some of the cases previously described.

In case *22* the disorder was diagnosed as Huntington's chorea. Records were secured from the upper portion of the trapezius and the rhomboideus major muscle during the lightning-like contractions which caused occasional jerks or shrugs of the shoulder. These records are shown in figure 8. Figure 8*A* shows two groups of action potentials which occurred during a momentary shrug of the shoulder. These involuntary movements did not occur in a rhythmic sequence. Figures 8*B* and 8*C* show other examples of the action potential responses which

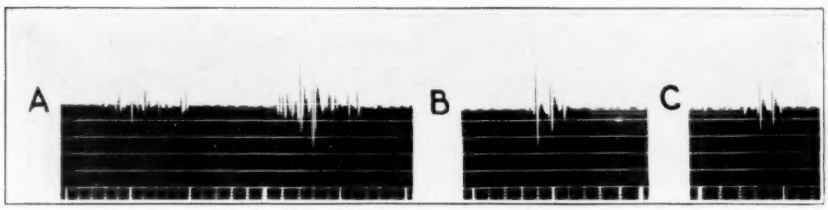

Fig. 8.—Action potentials from the right trapezius muscle of a patient with Huntington's chorea (case *22*) during lightning-like contractions. *A*, two groups of responses in quick succession, which vary in size and duration; *B* and *C*, isolated groups of responses of even shorter duration. The time intervals are twenty milliseconds.

occurred during the lightning-like contractions. In both of these records it will be observed that two units are discharged in very quick succession. Such groups of responses may be followed by complete inactivity of the muscle for many seconds, or in some cases for a few minutes, before another contraction appears. It is interesting that with the needle electrodes in the same location the involuntary contractions may produce large groups of responses like those shown in figure 8*A* or very brief groups like those shown in figures 8*B* and 8*C*. In the former case many motor units were active, whereas in the latter cases only a few were discharged. In some instances when a single motor unit was being recorded from, two responses of the same unit appeared in quick succession at a frequency of from 40 to 50 per second.

III. TORTICOLLIS

Four cases of torticollis have been studied electromyographically. All the patients had what might have been considered a neuropathic background or a partial justification for favoring a diagnosis of hysteria. In case 23, however,

signs of labyrinthine disturbance were noted, which pointed to an organic interpretation. It should be remembered, however, that the results of tests of vestibular function are not always to be relied on when the head of the patient is already rotated to one side. In case 26 there were also some organic symptoms which made the diagnosis of hysteria a questionable one. In the other two cases (cases 24 and 25) in the absence of significant neurologic findings the disorder was considered to be hysterical torticollis.

Records obtained from the cleido-occipitalis-cervicalis muscle in case 23, while the patient's head was drawn back, showed (fig. 9*B*) rhythmic groups of action potentials at 9 per second. Similarly, records (fig. 9*A*) made from the right sternocleidomastoid muscle in case 26, while the patient's head was turned toward the left and was shaking slightly, showed rhythmic groups of action potentials at a frequency of from about 7 to 11 per second. Figure 7*C* shows a record obtained from the left sternocleidomastoid muscle in case 24, while the patient's head was turned toward the right. In this record there is almost continuous electrical activity with definite tendencies toward a grouping of the responses. In this

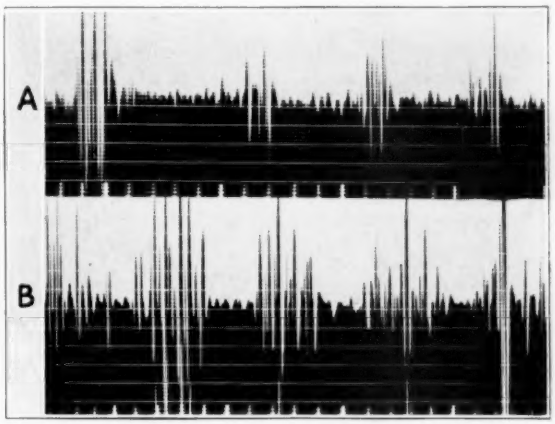

Fig. 9.—Irregular groups of action potentials from the right sternocleidomastoid muscle of a patient with a doubtful diagnosis of hysterical torticollis (case 26) while the head was turned toward the left and shaking slightly. *B*, rhythmic groups of responses from the cleido-occipitalis-cervicalis muscle of a patient with organic torticollis (case 23) while the head was involuntarily drawn backwards. The time intervals in *A* are twenty milliseconds; in *B* they are twenty-three milliseconds.

record, however, the grouping is entirely arrhythmic. The size and duration of the groups of action potentials vary widely. The same is true of the records (fig. 7*D*) from the right sternocleidomastoid in case 25, during the making of which the patient's head was rotated to the left.

IV. SPASTICITY

Case 27 was that of a patient with spastic paraplegia. The muscles of the quadriceps group were extremely spastic and rigid. When the needle electrodes were inserted in the rectus femoris muscle, with the leg supported and the patient attempting to relax, continuous motor unit responses were heard in the loud

speaker. Figure 10*A* shows a record of this activity. In this record the responses of a single motor unit occur regularly at a frequency of from 5 to 6 per second. The responses of other motor units, apparently not so near to the surfaces of the electrodes, may also be seen and at even lower frequencies. In a number of records obtained from the quadriceps group of muscles (rectus femoris and vastus lateralis muscle) the responses of single motor units occurred at frequencies of from 3 to 6 per second. Many active units were found throughout the muscle when the coaxial needle electrodes were inserted into different places. When the patient was asked to produce a weak voluntary contraction of the muscle the responses of many new units appeared in the records, at frequencies from 8 to 15 per second. These frequencies are characteristic of a normal weak voluntary contraction.

In this same patient a sustained patellar clonus could be initiated by a tap on the patellar tendon. Figure 10*B* shows a record obtained from the rectus

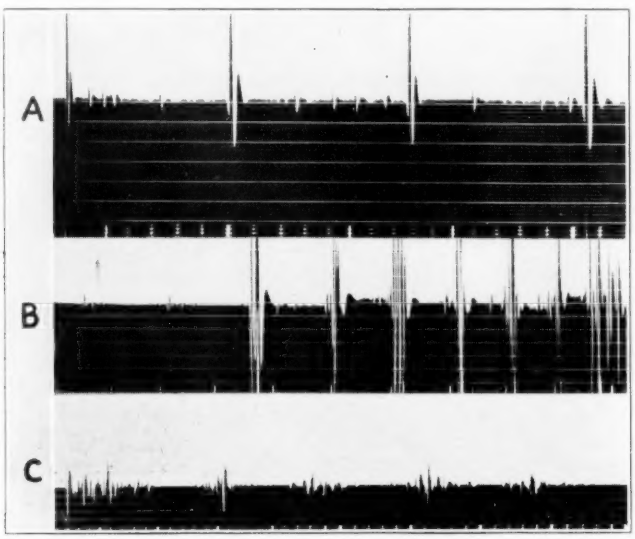

Fig. 10.—*A*, low frequency single motor unit responses from the spastic rectus femoris muscle of a patient with spastic paraplegia (case 27) while the leg was at rest. *B*, groups of action potentials from the rectus femoris muscle of H. K. (case 27) during sustained patellar clonus. Note the small action potentials accompanying the spastic state before clonus was elicited. *C*, record obtained with pad electrodes from the gastrocnemius muscle of a patient with compression of the cord (case 28) during nonsustained ankle clonus. The time intervals are twenty-three milliseconds.

femoris muscle during a sustained clonus. Before the tap on the tendon initiated the first clonic discharge the small responses of three motor units, at some distance from the electrodes, may be seen. These responses are characteristic of the spastic state, as are those shown in figure 10*A*. The brief and relatively synchronous groups of action potentials accompanying each clonic contraction occur at a frequency of from 8 to 9 per second.

In the case of another patient with a spastic disorder (case 28), records were obtained from the slightly spastic gastrocnemius muscle. Continuously active motor units were found in this case also, although the patient was attempting to relax. The frequency of the responses ranged from 6 to 8 per second. A nonsustained ankle clonus could be elicited in this patient by sharply dorsiflexing the foot. A record (fig. 10*C*) of this clonus was obtained by means of pad electrodes placed over the gastrocnemius muscle. The groups of action potentials accompanying each clonic contraction occur at a frequency of about 6 per second. The clonus usually persisted for about 7 or 8 contractions, the size of the responses gradually diminishing.

V. ATROPHY

Eleven cases of muscular atrophy have been studied. In these cases the disorders were diagnosed as follows: cases 29, 30, 31, 32 and 33, progressive muscular atrophy; cases 34 and 35, tumor of the spinal cord; cases 36 and 37, amyotrophic lateral sclerosis; case 38, peroneal muscular atrophy; case 39, poliomyelitis.

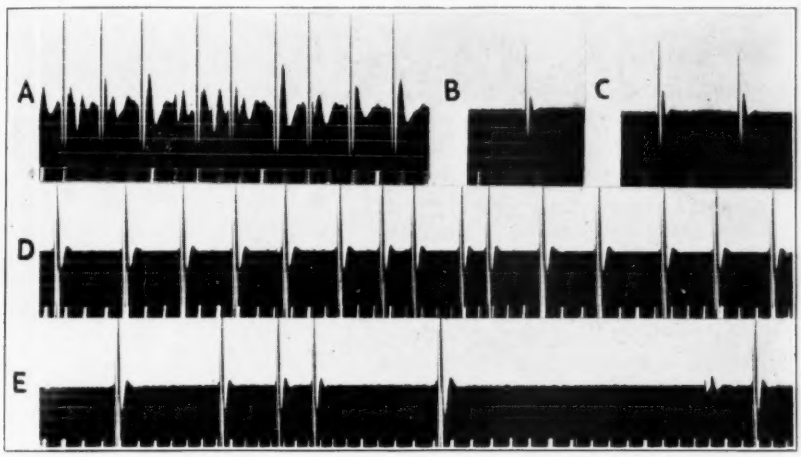

Fig. 11.—*A*, normal appearing responses of single motor unit from the biceps muscle of a patient with progressive muscular atrophy (case 30) during voluntary effort. *B* and *C*, isolated single motor unit responses from the triceps muscle of E. K. (case 30) during twitching of a fasciculus; *D*, normal-appearing responses of a single motor unit from the much atrophied biceps muscle of a patient with amyotrophic lateral sclerosis (case 36) during voluntary effort. *E*, responses of the same motor unit during fibrillary twitching with the arm at rest. The time intervals in *A*, *B* and *C* equal twenty-three milliseconds; in *D* and *E* they are twenty milliseconds

I have found that in the more atrophied muscles of these patients few intact motor units remain. However, the few active units that have been found appear to respond in a perfectly normal fashion during voluntary effort. Some of the units, possibly owing to an irritative process in the region of their respective anterior horn cells, discharge spontaneously and cause fibrillary twitching.

Figure 11*A* shows the response of a single motor unit recorded from the biceps muscle in case 30, during a voluntary contraction. The response of the motor unit appears to be normal in every way. It has a characteristic wave pattern,

uniform amplitude and a fairly regular rhythm. It has been found that single motor units in these patients, like those in normal human muscles, start discharging during a weak voluntary contraction at a frequency of between 5 and 10 per second. As the intensity of the contraction increases the frequency of the motor unit response increases. When the contraction represents the strongest voluntary effort the patient can make, the motor unit response is usually found to occur at at a frequency of from 40 to 50 per second. Thus the responses characteristic of an intact motor unit in the muscles of these patients are just like those in a normal subject.

The records shown in figures 11*B* and 11*C* show the responses obtained from a region of the triceps muscle, in this same patient, which exhibited twitching.

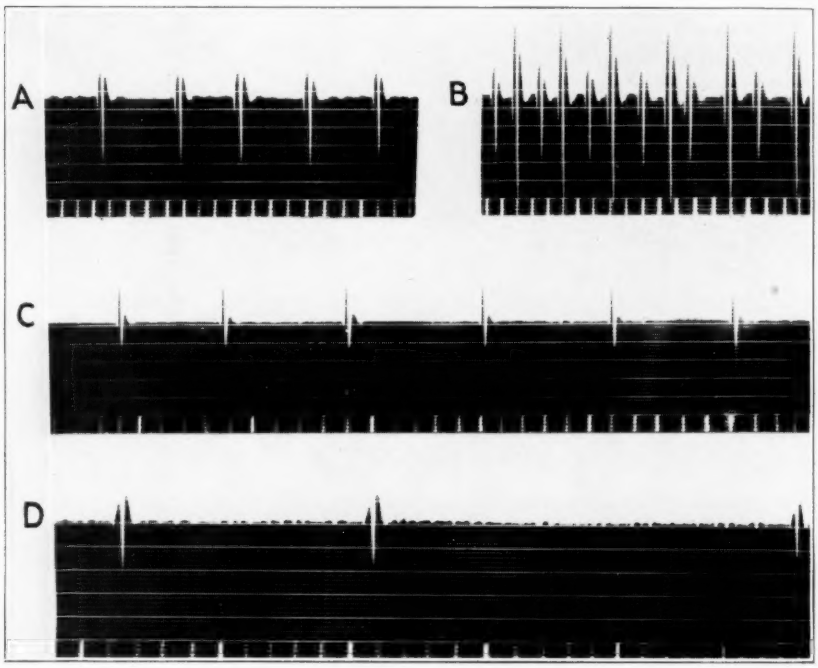

Fig. 12.—*A*, response of a single motor unit from the muscle of the forearm of a patient with poliomyelitis (case 39) during twitching of the fingers. *B*, same kind of record a few seconds later showing responses of two motor units out of phase. *C*, repetitive responses of a single motor unit during continuous fibrillation of a fasciculus in the triceps muscle of a patient with tumor of the cord (case 35). *D*, responses of a single motor unit during occasional twitching in the right trapezius muscle of a patient with progressive muscular atrophy (case 29). The time intervals are twenty-three milliseconds.

The needle electrodes were inserted in the muscle where a particular fasciculus had been observed to twitch. Sometimes a single twitch, and sometimes two or three successive twitches, occurred. In some instances there was continuous twitching for a few seconds at a time. The record shown in figure 11*B* is the response of a single motor unit during a single twitch. The record shown in figure 11*C* shows two successive responses of the same motor unit during a double twitch.

Figure 11*D* shows a record from the extremely atrophied biceps muscle in case 36, that of a patient with amyotrophic lateral sclerosis. The response of a single motor unit during voluntary effort occurs regularly at a frequency of about 15 to 20 per second. The electrodes were left in the same position and the patient was told to relax. All responses ceased. After a few seconds twitching was observed in the region of the electrodes and the same motor unit response was obtained. The record of these twitch responses is shown in figure 11*E*. The response pattern is identical with that in figure 11*D*, indicating that it is derived from the same motor unit. Apparently the anterior horn cell of this particular unit was in the early stages of degeneration, or else there was an irritative process in its immediate neighborhood, for the unit was still capable of responding normally to voluntary effort although when at rest it exhibited occasional twitches. The record shows that the twitching sometimes consists of a single isolated response and sometimes of two or three responses in succession.

Figure 12*C* shows a record of the continuous fibrillation observed in the right triceps muscle in case 35, in which a tumor of the spinal cord was suspected of being responsible for the atrophy and fibrillary twitching. The response of the single motor unit in this instance is repetitive and occurs at a frequency of 9 per second. Figure 12*D* shows a record of the irregular twitches which occurred in the right trapezius muscle in case 29.

Case 39 was that of a child with poliomyelitis. Twitching was observed in the muscles of the back and in the fingers. The pad electrodes were placed over the muscles of the forearm during the twitching of the fingers. Ordinarily with pad electrodes over a whole group of muscles during a contraction, the electromyographic record shows so many irregular responses that little, by way of analysis, can be done with it. In this case, apparently, the unit responsible for the twitching was near the surface and resulted in the responses shown in figure 12*A*. The frequency of the responses was about 10 per second. The electrodes were left in place, and another record (fig. 12*B*) was made a few seconds later. In this record the same unit continues to respond and a new one comes into activity at about the same frequency as, but just out of phase with, the first unit's response. The responses were followed by means of the loud speaker for several minutes. Sometimes both stopped for a few seconds and then either or both started to respond again.

COMMENT

The results of the study of paralysis agitans agree well with some of the findings reported by other investigators. For instance, the average frequency of tremor contractions recorded from the eight adult patients was 5.3 per second, with a range of from 4 to 7 per second. Bornstein and Saenger [10] found tremors in patients with paralysis agitans at a frequency of about 5 per second; Rehn [11] observed a frequency of 6 per second, and Cobb,[12] who obtained records from a much larger group, reported that the average frequency, as based on observations of sixteen adult patients, was 5.8 per second. Cobb found no significant

10. Bornstein, D. B., and Saenger: Deutsche Ztschr. f. Nervenh. **52**:1, 1914.

11. Rehn: Klin. Wchnschr. **1**:309 and 673, 1922.

12. Cobb, Stanley: Electromyographic Studies of Paralysis Agitans, Arch. Neurol. & Psychiat. **8**:247 (Sept.) 1922.

variation between the cases of typical parkinsonian syndrome and those of atypical manifestations, although he did find that in the case of a child the tremor frequency was considerably higher than in the cases of adult patients.

No significant differences in the frequency of groups of action potentials referable to the diagnostic classifications of the condition were observed in this series. The average frequency for the arteriosclerotic group (four patients) was 5.4 per second, while the average for the postencephalitic group (two patients) was 5.7 per second. There were, however, significant differences in frequency from patient to patient. For example, in case 2 there was a tremor frequency of from 4 to 4.5 per second, whereas in case 4 the frequency was from 6 to 7 per second.

In one case of paralysis agitans in which rigidity was well marked, Cobb [12] found small waves between the tremor contraction volleys which he thought were associated with the rigidity. He was careful to state, however, that these fine oscillations may have been due to the spread of responses from other muscles, since he was using pad electrodes. I am inclined to believe that this may have been the case, for in none of my records have I observed any activity of the motor units between groups of action potentials; this may have been due to a substratum of rigidity present. In all my patients there was some manifestation of rigidity, and in four of them definite cog-wheel effects could be produced on passive movement of a limb.

The records obtained during cog-wheel phenomena showed rhythmic groups of action potentials at approximately the same frequency as those observed during the resting and intention tremors. This suggested that perhaps the rhythmic "showers" of impulses which appear to be transmitted to the muscles almost continuously, whether tremors are observed or not, are responsible for the stiffness and rigidity found in patients with paralysis agitans. The rigidity does not appear to be accompanied by the asynchronous responses of motor units which I have observed in certain spastic states (cases 27 and 28).

Cobb [12] has called attention to the fact that the tremors in patients with paralysis agitans are extremely regular and maintain the same frequency for months. My results also indicate that the volleys of action potentials which accompany the tremors maintain a regular rhythm. In some of the records, for example in figure 1*A*, the rhythm appears to be as regular as that of the timing intervals.

These rhythmic groups of action potentials and the periods of complete quiescence between them indicate that groups of anterior horn cells are being discharged rhythmically. The rhythm is probably not inherent in the anterior horn cells, for if it were one might expect them

to discharge independently and out of phase with each other, as they do during voluntary activity. Pritchard [13] has suggested that the tremors of patients with paralysis agitans, as well as those sometimes observed in normal subjects during fatigue and strong voluntary effort, are due to the synchronous discharge of motor units. That there is a relatively synchronous discharge of motor units during the tremors is obvious, but the question of what determines this rhythmic discharge still remains. Pritchard implied vaguely that the synchronous nature of the discharge is due to an abnormal variation in the influence of the afferent nerves to the muscle on the discharge of the motor neurons. In line with this view is a suggestion by Denny-Brown,[2] based on an observation by Byrnes,[14] which indicated that the muscle spindles in patients with paralysis agitans undergo degeneration. Denny-Brown expressed the belief that the muscle spindles produce afferent impulses which have an inhibitory influence. Therefore, he reasoned, if they were degenerated in patients with paralysis agitans there would be no damping of the motor discharge, and rigidity would ensue. If only part of them were degenerated in the early stages of the disease there would be an improper balance, and tremor would result.

The hypothesis is logical enough, but there are several observations which are not in harmony with it. First, the work of Matthews [15] indicates that muscle spindles have chiefly an excitatory function and probably not an inhibitory one. Furthermore, on the basis of an abnormal variation in the flow of afferent impulses, how is one to account for the different frequencies of groups of action potentials (paralysis agitans, from 4 to 7 per second, and athetosis, from 2 to 11 per second) reported in this paper? Also, how is one to account for tremors which start spontaneously in an arm at rest? Finally, using a technic previously described [16] for measuring the inhibitory interval accompanying the "silent period" of the knee jerk in normal subjects, I have found in most of the patients a normal inhibitory period.

That the afferent flow of impulses influences the efferent discharge has been shown by Liddell and Sherrington,[17] Dusser de Barenne and Brevée,[18] Adrian and Zotterman [19] and others. This does not, I believe, explain the relatively synchronous discharge of motor units observed in my patients.

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13. Pritchard, E. A. B.: Brain **52**:510, 1929; **53**:344, 1930.

14. Byrnes, C. M.: A Contribution to the Pathology of Paralysis Agitans, Arch. Neurol. & Psychiat. **15**:407, 1926.

15. Matthews, B. H. C.: J. Physiol. **78**:1, 1933.

16. Lindsley, D. B.: Am. J. Physiol. **109**:181, 1934.

17. Liddell, E. G. T., and Sherrington, C.: Proc. Roy. Soc., London, s.B. **96**:212, 1924.

18. Dusser de Barenne, J. G., and Brevée, J. F. G.: J. Physiol. **61**:81, 1926.

19. Adrian, E. D., and Zotterman, Y.: J. Physiol. **61**:151, 1926.

In view of the spontaneous nature of the tremors and other involuntary movements which arise when the limbs are at rest, the unusual regularity and uniform frequency of the motor discharges in different muscles of the same patient, and the influence of emotional excitement in initiating and modifying the tremors and involuntary movements, I believe that rhythmic discharges arising in the higher levels of the central nervous system are responsible for the rhythmic phenomena I have observed in the muscles.

Rhythms of the central nervous system, both spontaneous and automatic, have been demonstrated in the isolated brain stem of the gold fish by Adrian and Buytendijk.[20] Adrian [21] has also demonstrated spontaneous rhythms in the isolated ganglia of the water beetle. Perhaps, therefore, it is not too bold to suggest that certain of the motor nuclei in the basal ganglia are capable of spontaneous rhythmic discharge. It is possible that these nuclei, under the influence of specific lesions, discharge rhythmically at frequencies corresponding to those found in the muscles of my patients. Also, as Cobb [12] has pointed out in connection with the faster rate of tremors in children, the general metabolism may influence the frequency of the discharge of a center.

Since voluntary attempts by a normal subject to imitate the tremors of patients with paralysis agitans and athetosis have resulted in less precise and less rhythmic groups of action potentials, it is perhaps reasonable to assume that the rhythmic discharges, at least in the patients with paralysis agitans and athetosis, are not of cortical origin. Whether the lesions commonly found in the striatum, pallidum, substantia nigra, subthalamic bodies or elsewhere in the brain stem in patients with paralysis agitans and athetosis "release" motor nuclei of the basal ganglia from the control of each other or from possible cortical influence is impossible to say.

The pathologic processes of the various forms of paralysis agitans vary considerably and result from different causes, but it is also true that the syndromes themselves vary. The same holds true for athetosis. The rhythmic groups of action potentials which accompany the tremors of paralysis agitans varied from 4 to 7 per second in different patients. The rhythmic response groups during the involuntary movements in the other patients (patients with athetosis, organic torticollis, multiple sclerosis and bromide poisoning) varied still more widely, the variation amounting to from 2 to 11 per second.

It is interesting in this connection that after partial section of the vestibulospinal and reticulospinal tracts in the anterior column in case 11, the frequency of the groups of action potentials (figs. 4 *A* and 4 *B*)

20. Adrian, E. D., and Buytendijk, F. J. J.: J. Physiol. **71**:121, 1931.
21. Adrian, E. D.: J. Physiol. **72**:132, 1931.

decreased. This seems to indicate that cutting off the influence of certain nuclei changes the frequency of the discharges imposed on spinal motor neurons and relieves the intensity of the involuntary movements.

Another observation which has a possible bearing on the nature of the discharging centers responsible for involuntary movement is the record (fig. 5*C*) obtained from a patient during clonic convulsions produced by pressure on the carotid arteries. Perhaps owing to cerebral anoxemia the cortical control of subcortical centers was "released," thus initiating rhythmic discharges which caused the clonic convulsions at a frequency of about 8 per second. In agreement with this view, Simpson and Derbyshire [22] found that the action potentials normally present in the motor area of the cortex in a lightly anesthetized cat disappeared during anoxemia produced by compression of the carotid arteries. In more than 50 per cent of their animals clonic contractions of the muscles of the forelimbs and hindlimbs coincided with the loss of the electrical activity of the cortex.

Although too few cases have been studied and it is always difficult to be sure of the diagnosis in cases of hysterical torticollis, the response groupings observed in cases 24 and 25, in which the disorder was believed to be of hysterical nature, were arrhythmic and irregular in size and duration as compared with the rhythmic and uniform response groups obtained in case 23, in which definite signs of organic involvement were present. The record (fig. 9*A*) obtained in case 26 shows a fairly rhythmic grouping of responses, although the rhythm varies rather widely. The diagnosis in this case was extremely questionable, although the diagnosis of hysteria was slightly favored. The decision as to whether the absence of a regular rhythmic discharge in hysterical torticollis as opposed to its presence in organic torticollis is a diagnostic differential will have to await further evidence. My results, as well as those of Cobb,[23] indicate that hysterical contractions are accompanied by irregular groups of action potentials.

The spontaneous nature of the brief and irregularly appearing response groups found in Huntington's chorea and the similarity in these respects to the responses which accompany the twitching in progressive muscular atrophy suggests that these discharges may also be initiated by an irritative process. Each response group usually consists of several responses of motor units which occur asynchronously. The pattern of the response group is not significantly different from one which might be obtained during an exceedingly brief voluntary

22. Simpson, H. N., and Derbyshire, A. J.: Am. J. Physiol. **109**:99, 1934.

23. Cobb, Stanley: Electromyographic Studies of Muscles During Hysterical Contraction, Arch. Neurol. & Psychiat. **4**:8 (July) 1920.

contraction. The groups of action potentials which accompany the lightning-like contractions in chorea differ from responses which are associated with muscular twitching in that they are of longer duration and usually consist of responses of more than one unit. This suggests that spontaneous discharges are probably of central origin rather than due to a local irritation of anterior horn cells.

The pathologic reports indicate that in patients with progressive muscular atrophy and amyotrophic lateral sclerosis the anterior horn cells associated with a much atrophied muscle may be in a state of complete or of partial degeneration or may be perfectly normal in appearance. My results from tests on the atrophied muscles of such patients are in agreement with the pathologic findings, for I find that many portions of the remaining tissue are completely inactive electrically, that some units respond with isolated twitches and that others give perfectly normal responses during voluntary contraction.

My results from the investigation of spastic states confirm those of Gregor and Schilder [24] and Bornstein and Saenger [10] in indicating that action potentials are continuously present. In addition, I have found that the responses of motor units may be obtained throughout a spastic muscle. The impressive thing about the responses of motor units recorded from a spastic muscle is that the frequency is unusually low (fig. 10 *A*). During voluntary contraction of the same muscle the responses of the same motor units increase in frequency. The same degree of tenseness observed in the spastic muscles can be duplicated in a normal muscle only by extremely intense voluntary effort, which causes motor units to respond at a frequency of about 40 to 50 per second.

In one of my patients (case 27) clonic discharges during patellar clonus occurred at a frequency of from 8 to 9 per second; in the other patient (case 28) the clonic discharges accompanying a nonsustained ankle clonus occurred at a frequency of 6 per second. Cobb [25] found the contractions of patellar clonus to occur at frequencies between 5.7 and 8.5 per second and those of ankle clonus at frequencies between 5.2 and 7.9 per second. Similar frequencies have been reported for foot clonus by Gregor and Schilder [24] and Bornstein and Saenger.[10] Viets [26] reported the frequency for patellar clonus in man to range from 8.8 to 9.7 per second. It appears therefore that the rate of clonic discharge may vary from patient to patient but for the most part falls within the range from 5 to 9 per second.

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24. Gregor and Schilder: Ztschr. f. d. ges. Neurol. u. Psychiat. **14**:359, 1913.
25. Cobb, Stanley: Bull. Johns Hopkins Hosp. **29**:247, 1918.
26. Viets, H.: Brain **43**:269, 1920.

SUMMARY

The electromyograms obtained from the muscles of patients with paralysis agitans during rigidity and tremor consisted of rhythmic groups of action potentials separated by periods of inactivity. The average frequency of the rhythmic groups in the eight patients studied was 5.3 per second. The same frequency was found in other muscles during both resting and intention tremors.

Rhythmic groups of action potentials were also found during the resting and intention tremors in a patient with multiple sclerosis and in a patient with bromide poisoning. The rhythm was slightly faster during the intention tremors in both cases.

Action potentials recorded from the affected muscles of eleven patients with athetosis showed a rhythmic grouping at frequencies of from 2 to 11 per second.

The electromyograms from the muscles of patients with hysterical torticollis consisted of arrhythmic groups of action potentials which varied in size and duration, whereas those from the muscles of patients with organic torticollis consisted of rhythmic discharges.

The lightning-like contractions which were observed in the muscles of a patient who had Huntington's chorea were shown to be of tetanic nature and not unlike a brief voluntary contraction. The groups of action potentials accompanying each contraction varied in size and duration.

Rhythmic responses of single motor units were recorded from various parts of spastic muscles. The frequency of the responses was unusually low as compared with that ordinarily found during voluntary contraction.

Very few intact motor units were found in the extremely atrophied muscles of patients with progressive muscular atrophy and amyotrophic lateral sclerosis. Most of the active units that remained functioned normally during voluntary contraction. The records obtained during muscular twitching showed isolated and repetitive discharges of a single motor unit.

The nature and origin of the discharges responsible for the tremors and other involuntary phenomena observed have been discussed.

Dr. Stanley Cobb and Dr. Hallowell Davis provided facilities for this work. Dr. James B. Ayer permitted me to use patients from the neurologic service and Dr. T. J. Putnam allowed me to work with patients from his service at the Boston City Hospital.

Technical and Occasional Notes

A METHOD OF SKELETAL TRACTION FOR TREATMENT OF FRACTURE DISLOCATION OF CERVICAL VERTEBRAE

THOMAS I. HOEN, M.D., MONTREAL, CANADA

It has long been recognized that in the handling of vertebral fractures and dislocations all attention must be directed to protection of the spinal cord. With this in mind, manipulation of a fracture and attempts at reduction of the displacement were frowned on for many years. The reasons given were: (1) If the cord was damaged by the original trauma, the damage is irreparable, and additional movement of the fragments, even toward a better position, can cause more disturbance and cannot improve the condition of the damaged cord, and (2) if the cord was not damaged, a skeletal deformity is of little consequence. With physicians of this school of thought treatment remained simple immobilization to allow consolidation.

Recently, however, results have been obtained by careful manipulation and traction which seem to indicate clearly the advantage of reducing the bony deformity when this can be accomplished without further injury to the patient or to the spinal cord.

It is not my purpose in this communication to discuss the value or the result of treatment by this method. I think that traction and reduction are the ideal method and shall describe here a simple form of skeletal traction which I have used during the past three years and have found simple in application and remarkably efficacious.

The apparatus can be applied with the patient either in bed or on an operating table. In the former case it is necessary to have a low-headed bed (the patient may be turned, so that the foot of an ordinary bed is used), and the mattress must be raised so that the operative field may be set up, exposing the top of the patient's head. It is important to support the head with sand-bags and to have an assistant who supports the chin from below to avoid unnecessary movement.

Two paramedian incisions 5 cm. long are made about 4 cm. from the midline in the parietal region, the exact location depending on the position desired for the head. (Since this is nearly always one of extension, the bur holes will be placed somewhat anterior to the central area.) A bur hole is then made at each end of both incisions. A motor driven bur is preferable, since it can be used with less shaking of the head. A Gigli saw guide or a grooved director is then passed extradurally from one bur hole to the other on the same side and followed with a Gigli saw. Several strokes are taken with the saw to create a groove

From the Department of Neurosurgery, St. Luke's Hospital.

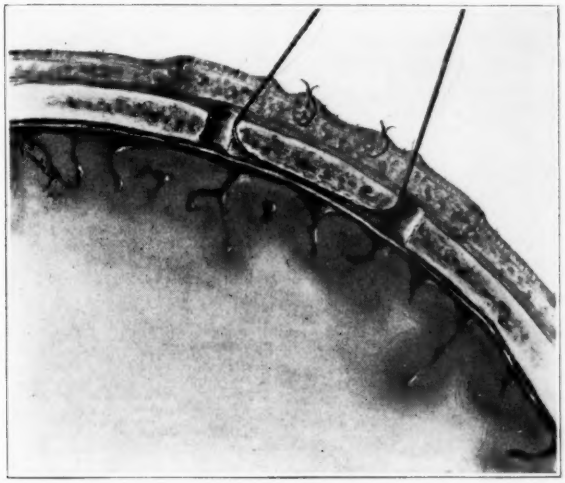

Fig.1.—The position of the wire in relation to the bur holes and the cranial structures.

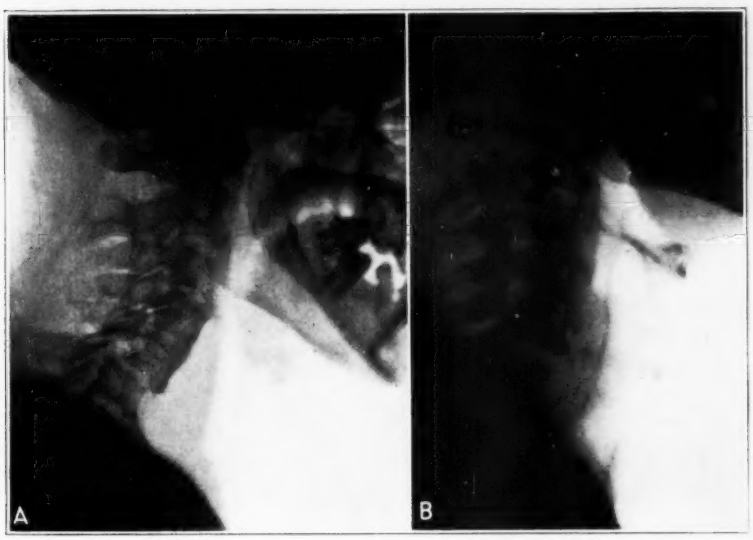

Fig. 2.—*A*, roentgenogram taken on admission, showing anterior displacement of the fifth cervical vertebra. *B*, roentgenogram taken seventy-two hours after the application of traction.

in which the traction wire will rest without impinging on the dura. The saw is then withdrawn, and the traction wire is passed through in the same manner. The same procedure is carried out on the other side, and the four ends of the traction wires are gathered together and fastened to the ordinary traction apparatus. The wounds are closed in two layers with fine silk, the traction wires being allowed to escape from the ends of the incisions. Three or four gage chromium-plated wire is probably the best material to use. Small dry dressings are then

Fig. 3.—Photograph of the patient in bed with traction applied.

applied with liquid adhesive, the wires being allowed to pass through these.

The advantages of this apparatus over the forehead and occiput or chin and occiput collar are obvious. The patient is not conscious of the apparatus at all and usually experiences immediate relief from pain in the region of the fracture. There is no difficulty in keeping the apparatus in place, and difficulties from pressure on the skin are avoided; also, as much traction as is desired can be applied for any length of time. I have found that from 10 to 20 pounds (4,535 to 9,070 Gm.)

usually reduces the fractures within six hours, after which 6 pounds (2,721 Gm.) is sufficient to maintain the fractured parts in position. However, if greater traction is necessary, the apparatus will easily support it. For the patient shown in the illustrations 22 pounds (9,977 Gm.) was applied and roentgenograms were made at twelve hour intervals; satisfactory reduction was not obtained until the third day.

This form of skeletal traction may be used in conjunction with laminectomy when the latter is indicated. In fact, the disastrous results obtained in the operative treatment of fractured vertebrae may be due in large part to the fact that the operative interference with the structures which are helping to support the fractured part allows further dislocation. Preliminary application of adequate traction aids in preventing this occurrence.

Case Reports

INSULIN IN TREATMENT FOR SYMPTOMS CAUSED BY WITHDRAWAL OF MORPHINE AND HEROIN

A Report of Ten Cases

PHILIP PIKER, M.D., CINCINNATI

Many methods for the management of the symptoms produced by withdrawal of morphine have been advocated, one of the more recent of which was proposed in 1930 by Manfred Sakel,[1] who suggested the administration of insulin as symptomatically ameliorating and physiologically correct. For the past eighteen months I have used this method, with results which in general corroborate the reports of other clinicians.[2] I include here a report of the first ten consecutive cases in this clinic in which such treatment was instituted.

The regimen of abrupt and complete withdrawal was rigidly adhered to regardless of the quantity of the drug to which the patient had become addicted. Ten units of insulin was given to each patient shortly after admission, in order to observe and anticipate a possible hypoglycemic reaction. Thereafter insulin was given only as indicated by the patient's discomfort. No arbitrary size or frequency of dose was established, the correct dose for each patient being discovered by increasing the amount with each injection until the dose which relieved the symptoms was reached. This amount was then considered the effective dose and was given as often as the patient's symptoms warranted. Protection against a hypoglycemic reaction with anticipatory administration of dextrose was not considered necessary, and dextrose was given only when signs of hyperinsulinism developed. A mild attempt was made to regulate the administration of the insulin so as to give a dose from fifteen to thirty minutes before each meal in order to promote the intake of food, but

1. Sakel, M.: Insulin in Morphine Addiction, Deutsche med. Wchnschr. **56**:1777 (Oct. 17) 1930; New Method of Treatment: Administration of Insulin Simultaneously with Withdrawal of Morphine, Ztschr. f. d. ges. Neurol. u. Psychiat. **143**:506, 1933.

2. Anton, G., and Jacobi, J.: The Treatment of Morphinism with Insulin and Grape Sugar, Klin. Wchnschr. **9**:1547, 1930. Jacobi, J.: Advances in the Treatment of Morphinism with Insulin and Grape Sugar, Monatschr. f. Psychiat. u. Neurol. **80**:221 (Sept.) 1931. Modern, Fred S.: Insulin in the Treatment of Chronic Morphinism, M. J. & Rec. **136**:163 (Aug. 17) 1932. Howard, Merle Q.: Treatment of Morphinism with Insulin: A Preliminary Report, Wisconsin M. J. **32**:448 (July) 1933; Insulin as an Aid in Withdrawing Morphine, Tr. Am. Therap. Soc. **33**:103, 1933. Schaffer, Karl: Sudden Withdrawal of Morphine by Means of Insulin, Psychiat.-neurol. Wchnschr. **36**:121, 1934. Delaville, M., and Dupouy, R.: Method of Rapid Disintoxication of Morphinomaniacs with Emulsions of Lipids, Bull. Acad. de méd., Paris **111**:441, 1934.

this distribution of medication was quickly altered if the time of occurrence of the patient's symptoms demanded a change.

To supplement the insulin, sedatives (phenobarbital, barbital, sodium amytal and paraldehyde) were used moderately, chiefly in an attempt to alleviate insomnia. A sedative bath was given the patient at bedtime.

REPORT OF CASES

CASE 1.—A man, aged 55, had been addicted to the use of narcotics for thirty years, during which time he had undergone twenty-seven "cures" (both voluntary and enforced). Until about one year before he was admitted to the hospital he had used morphine, but during the past year he had been taking from 5 to 6 grains (0.3 to 0.36 Gm.) of heroin daily by hypodermic injection. The symptoms attending withdrawal of the drug began twelve hours after he was admitted to the hospital and included restlessness, insomnia, nausea, vomiting, profuse diaphoresis, generalized aching, abdominal pain, constipation and weakness. Fifty units of insulin in doses of from 10 to 20 units administered the first day gave no relief. Sixty units in 20 unit doses on the second day diminished the restlessness somewhat and enabled the patient to retain small quantities of nourishment. One hundred and ten units on the third day brought moderate relief from the symptoms generally, four doses of 20 units and one dose of 30 units being administered. The 30 unit dose was found to be most completely effective and was adhered to thereafter. One hundred and twenty units on the fourth day, 150 units on the fifth day, 120 units on the sixth day, 120 units on the seventh day, 60 units on the eighth day and 60 units on the ninth day completed the treatment. No insulin was needed after the ninth day, the patient remaining free from symptoms, except for constipation and occasional vomiting, which was not associated with the ingestion of food. From the fourth day, the response to each dose of insulin became more marked and more prolonged, with the intake of food increasing rapidly. The patient left the hospital after five weeks. He stated that this method of withdrawal was the most comfortable of the numerous treatments he had undergone.

CASE 2.—A man, aged 30, who was addicted to the use of morphine, using it hypodermically, had begun the use of the drug in 1926, had remained an addict only one year, and had discontinued its use in a hospital by the method of abrupt withdrawal, with narcosan (a proprietary preparation of plant extractives) utilized as a substitute during the treatment. The symptoms attending withdrawal were extremely severe and persisted from ten to fourteen days. He remained free from the habit until one year before he was admitted to the hospital and had been using from ½ to 1 grain (0.03 to 0.06 Gm.) daily during the past year. He had the last dose thirty-six hours before he was admitted to the hospital and began to have withdrawal symptoms a few hours before admission. The symptoms included severe abdominal cramps, diarrhea, nausea, severe cramping pains in the upper and lower extremities, sneezing, yawning, profuse lacrimation, marked generalized tremor and a feeling of apprehension. He was given 10 units of insulin at 3 a. m., without effect. At 8:30 a. m. he was given 15 units, with moderate effect, and was able to eat and retain a small portion of breakfast. Twenty units administered at 10:30 p. m. relieved all symptoms except the tremor and the feeling of apprehension. Twenty-five units were given at 11:30 p. m., with complete remission of all symptoms and resultant euphoria. Following this dose, which was apparently the effective dose, the patient ate and retained lunch. The same amount was given at 1 p. m. and at 3:25 p. m.; both of these injections were followed by moderate signs and symptoms of hypoglycemia, which were

counteracted readily by the administration of dextrose in orange juice. A further dose of insulin was not required; the patient remained comfortable and was up and about throughout the rest of his stay in the hospital. Appetite and elimination were normal, and sleep was satisfactory, a sedative being necessary only the first night after the treatment was stopped. He was returned to the police after four days in the hospital. In comparing this method with previous treatment the patient stated that the regimen with insulin was definitely more satisfactory.

CASE 3.—A man, aged 43, had been addicted to the use of narcotics for fourteen years, using morphine for the first eight years and heroin during the last six. Addiction was continuous; during the past several months he had been taking 20 grains (1.3 Gm.) of heroin intravenously daily. He had had the last dose on the evening before he was admitted to the hospital, and he began to complain of generalized aching and abdominal cramps a short time after he entered the ward. In addition, there soon developed the following symptoms: restlessness, nausea, vomiting, marked muscular atonia, delirium, insomnia, anorexia, chills, lacrimation and abdominal cramps. Eighty units of insulin in 20 unit doses was given on the first day, with little relief. One hundred and sixty units in 20 and 30 unit doses was tolerated without hypoglycemic reaction on the second day, but symptomatic relief was only slightly greater than on the first day. During the third day only one dose of 20 units was given, the patient remaining for the most part apathetic. He was able, however, to retain a small amount of nourishment. On the next day he responded appreciably to doses of 30 units, and he was kept fairly comfortable with 90 units on the fourth day, 60 units on the fifth day, 100 units on the sixth day, 120 units on the seventh day and none thereafter. From the fourth day, the patient took nourishment well and began to sleep increasingly well each night, with a diminishing need for sedatives and with disappearance of all symptoms except restlessness and abdominal cramping. On the eighth and ninth days he was free from symptoms except for inability to sleep more than four or five hours a night (with or without a sedative). He was discharged from the hospital on the tenth day. The patient, a taciturn and rigid person, was noncommittal concerning the value of the treatment with insulin as compared with his previous experiences with other methods of withdrawal.

CASE 4.—A woman, aged 27, had used heroin for six years, needing from 7 to 8 grains (0.45 to 0.6 Gm.) daily (intravenously) for the past three and one-half months. She had taken the last dose a few hours before she was admitted to the hospital, and she began to suffer from the withdrawal about eighteen hours after admission. The symptoms were marked restlessness, nausea, vomiting, severe abdominal cramps, generalized muscular twitching, anorexia, weakness, insomnia, profuse diaphoresis and apprehension. During the first three days 20 units of insulin per dose were administered to alleviate the symptoms, the total amount used being 60 units daily. There was a fairly severe hypoglycemic reaction with this regimen, necessitating protection by the intravenous administration of dextrose (50 per cent solution) after each injection of insulin. Consequently, though three injections of insulin per day were insufficient to give the patient continuous comfort, it was not deemed advisable to administer the insulin more frequently. On the fourth and fifth days two doses of 10 units each were sufficient to maintain the patient in a fairly comfortable state without the aid of dextrose. Barbiturates were given rather freely during the first three days but were not needed thereafter. Except for weakness, apprehension, restlessness and nausea, the patient was free from symptoms when she insisted on leaving the hospital on the fifth day because she was not permitted to have all the liberty she wanted. The nausea

was sporadic during her stay in the hospital; when the insulin was administered before meals no difficulty was experienced in maintaining a fairly good nutritional intake throughout.

CASE 5.—A man, aged 32, had been addicted to the use of drugs for a year and a half, using morphine for the first fourteen months and heroin during the past four months. He had been taking 8 grains of heroin per day intravenously. He had the last dose twenty-four hours before he was admitted to the hospital, and when admitted to the ward he complained of generalized aching, nausea, vomiting, lacrimation, restlessness, weakness, abdominal cramps and diarrhea. One hundred and forty units of insulin per day in 20 unit doses afforded little relief during the first two days, though the insulin was tolerated without signs of hypoglycemia. Ninety units in 30 unit doses on the third and fourth day began to have an appreciable effect on all the symptoms and enabled the patient to retain a moderate amount of nourishment. Sixty units on the fifth day, 120 units on the sixth day and 90 units on the seventh day made the patient increasingly and almost continuously comfortable, with sleep and intake of food satisfactory. Insulin was not needed on the eighth and ninth day, the patient remaining free from symptoms except for occasional moderate epigastric pain. He was discharged from the hospital on the ninth day.

CASE 6.—A man, aged 29, had been addicted to the use of morphine for nine years and for the past six or seven weeks had been taking 4½ grains (0.28 Gm.) per day intravenously. He had undergone several "cures" previously. He was admitted to the hospital forty-eight hours after the last dose of morphine and was acutely ill. The symptoms were severe pain in the legs, nausea and vomiting, diarrhea, insomnia, marked muscular atonia and yawning. Thirty units of insulin per dose was needed for relief from symptoms, and this amount was administered twice a day for four days. No signs of hypoglycemia developed. The patient obtained complete relief from symptoms with the establishment of the regimen with insulin, and the course in the hospital was pleasant. Appetite and elimination were normal on the second day after the treatment was instituted, and the patient was able to obtain sufficient sleep without the use of a sedative. He was discharged six days after he was admitted, in good condition, complaining only of the occasional recurrence of moderate pain in his legs. He had tried gradual withdrawal, substitution of cocaine and narcosis in previous attempts to end his dependence on morphine, and he stated that the regimen with insulin was the most satisfactory method.

CASE 7.—A man, aged 42, had been addicted to the use of morphine for twenty years and had been using 10 grains (0.6 Gm.) daily intravenously for several months previous to hospitalization. On admission he had withdrawal symptoms, which included generalized aching, generalized tremor, apprehension, insomnia, nausea and vomiting, and severe pain in the lower portion of the lumbar region. Twenty-five units was tried as the effective dose, and hypoglycemia did not follow. Three or four doses per day were administered for five days, and considerable amounts of sodium amytal by mouth were also administered. Appetite and ability to retain food were good throughout the regimen with insulin. Other withdrawal symptoms, however, responded only in part and for only a brief period following each injection of insulin, the course being difficult for the first seven days. He was discharged after twelve days.

In this case insulin was given cautiously. I was absent during the greater part of this patient's stay in the hospital, and it seems to me that a more generous use of insulin might have produced more satisfactory results. Certainly the effec-

tive dose was not reached, though the patient's tolerance for insulin apparently would have permitted the administration of larger quantities.

CASE 8.—A woman, aged 28, who was addicted to the use of morphine hypodermically, had used the drug intermittently for ten years because of discomfort incidental to eight surgical operations. Previous to the period immediately preceding admission to the hospital she had never used the drug continuously for longer than three months, had never needed more than ½ grain (0.03 Gm.) per day and had had no difficulty in discontinuing its use. The period leading to hospitalization, however, had covered an entire year, during the last month of which she had been using 1¼ grains (0.08 Gm.) daily. She began to have withdrawal symptoms twenty-four hours after the last dose of morphine, the symptoms including hot flashes, nausea and vomiting, diarrhea, diaphoresis, insomnia, apprehension and a sensation of weakness. Twenty units of insulin was found to be the effective dose; on the second day in the hospital she received a total of 65 units; protection with dextrose was not necessary. The symptoms were markedly reduced following each injection of insulin, and after the second day insulin was not needed. She was comfortable throughout the remainder of the period of hospitalization, appetite and elimination being satisfactory, with only moderate insomnia persisting and necessitating the administration of phenobarbital and barbital at night. She remained in the hospital seven days.

CASE 9.—A man, aged 43, had been addicted to the use of morphine for eleven years, with three brief intervals of abstinence. He had always taken the drug by mouth. For the six months previous to hospitalization he had been using 7½ grains (0.5 Gm.) daily, having had the last dose on the morning of the day of admission. Withdrawal symptoms developed thirty-six hours after the last dose and included severe pain in the lower portion of the lumbar region, hot and cold flashes, a sensation of drawing and jerking in the muscles of the forearms, nausea and vomiting, diarrhea, yawning, sneezing, lacrimation, nervous tension, insomnia and anorexia. On the first day after admission the patient was given 60 units of insulin in 20 unit doses, with definite relief from symptoms. He received 160 units on the second day in 20 unit doses, 140 units on the third day and from three to five doses of 15 units on each day thereafter until the last two days in the hospital, when the administration of insulin was discontinued. No hypoglycemic reaction occurred at any time. All the symptoms were entirely eliminated by the insulin from the onset of the treatment, with the exception of the pain in the lumbar region (which was considerably diminished) and the insomnia. Thus, during the entire stay in the hospital the patient was relatively comfortable. He was discharged after eight days.

CASE 10.—A woman, aged 36, had been addicted to the use of morphine for twelve years, at times using the drug hypodermically in amounts up to 30 grains (2 Gm.) daily, but for the six weeks previous to hospitalization she had been adjusting herself to 6 grains daily taken intravenously. She had had the last dose thirty-six hours previous to admission and was admitted to the hospital complaining of generalized aching, weakness, severe abdominal cramping, nausea, vomiting, anorexia and pain in the lower portion of the lumbar region. She was given 70 units of insulin in twenty-four hours, obtaining considerable relief from all symptoms with the exception of nausea and pain in the lumbar region. Maximum relief was noted following a dose of 25 units, the largest dose given. Mild signs of hypoglycemia following this dose were readily controlled with orange juice. The patient was taken from the hospital by the federal authorities on the day after admission.

COMMENT

This paper is concerned merely with the amelioration of the acute symptoms attending withdrawal of morphine or heroin. It is to be regretted that the social status of the patients and the conditions under which most of them were admitted and released precluded the possibility of a stay in the hospital of sufficient length to rehabilitate them completely physically and to permit investigation and combating of the psychogenic factors responsible for their dependence on narcotics. The usual gamut of reasons for the incarceration of narcotic addicts in a municipal hospital are well known. It will suffice here to reemphasize that these reasons are not conducive to complete cooperation on the part of the patient and that many municipal hospitals are not equipped to give the more cooperative patient of this sort the amount of psychiatric attention or the length of hospitalization that he deserves. Studies of the sugar content of the blood were not made in this group of cases.

The relief obtained from insulin by morphine addicts during withdrawal merits a complete investigation as to a causal relationship. The ameliorating effects of insulin recall the desire of many addicts for sweets and the fact that opium derivatives were used by the medical fathers in the treatment of diabetes mellitus; and the evidence in the group of cases reported in this paper suggests that most morphine addicts during withdrawal have an extraordinarily high tolerance for insulin. These points indicate that there is a disarrangement of the carbohydrate metabolism, either direct or indirect, during addiction to the use of morphine and during withdrawal. Insufficient research along this line does not permit the drawing of definite conclusions, though the autonomic nervous system and the endocrine system probably should bear the brunt of more intensive investigation than has thus far been made in this connection.

A point that is of more than mere academic interest is the surprising tolerance for insulin exhibited by these patients. In but three of the ten cases reported here were signs of hyperinsulinism noted. In only one of the three cases was there a reaction severe enough to cause limitation of the dose of insulin to an amount less than sufficient to give the patient maximum relief from withdrawal symptoms. In the other two cases the hypoglycemic reactions were mild and in no way interfered with the course of treatment. In the remaining seven cases, quantities up to 160 units in twenty-four hours produced no untoward results. The caution with which internists administer insulin to patients with various types of nondiabetic diseases seems for the most part unnecessary for patients with conditions of the type described in this paper.

That a diminution in the patient's discomfort is obtained by the administration of insulin seems well established, both from the results achieved in my cases and according to the reports of other clinicians. Though it is possible that the element of suggestion plays some part in the effect of insulin given hypodermically, it is my impression that the value of the drug is chiefly physiologic. Inadequate doses produced no effect in alleviating the symptoms, which tends to minimize the value of suggestion. In addition, whether or not the patient knew what he was getting by injection apparently had little to do with the results obtained. It is also significant that each of the patients described definite relief

from discomfort in from ten to fifteen minutes from the time of the injection of an effective dose of insulin, though none was given any hint of how soon to expect relief.

In estimating in advance in the individual case the degree to which the treatment is likely to be effective, an important guide is apparently the amount of drug to which the patient has been addicted just prior to withdrawal. The effectiveness of insulin would seem to be less in patients using the larger amounts of the drug. It might be wise in cases in which large quantities have been used to condition the patient to smaller doses of the drug before introducing the sudden substitution of insulin, particularly if the patient's physical condition is ominous or if a severe neurotic factor exists.

Heroin addicts, in my experience, respond less readily to insulin than do persons addicted to the use of morphine. In my series, however, the patients who had used heroin undoubtedly had more intense psychopathic trends and were of a lower caliber socially than were the majority of the morphine addicts. Their complaints and conduct were consequently more difficult to evaluate comparatively from the point of view of actual physiologic benefit derived. Nevertheless, even those patients had a less stormy course during the regimen with insulin than did patients with similar symptoms observed in our past experience who received ordinary sedative aid.

The one patient in this group who was accustomed to the oral ingestion of morphine enjoyed a relatively comfortable course, even though he had been using comparatively large doses of the drug.

The alleviation of the physical discomfort is the primary demand of the patient suffering from withdrawal symptoms; and from this standpoint alone my experience with insulin has indicated that it is a valuable aid in the management of such patients. An equally important factor, and one which is frequently neglected in many of the advocated methods of withdrawal of morphine, is the maintenance or reestablishment of the nutritional state of the patient. In every case in which I have administered insulin, including the cases of the more refractory patients who had been taking heroin or large quantities of morphine, some nourishment was taken and retained as early as the second day after the onset of symptoms; in each case the patient was taking and retaining food and liquids satisfactorily after three days. The importance of this factor cannot be overemphasized, particularly in municipal hospitals, in which the patient's stay is perforce short and on discharge from which his chances for maintaining abstinence from the drug are definitely increased by an adequate physical status.

In comparing the results obtained from treatment with insulin with those effected by the ordinary means of handling withdrawal of morphine and heroin in my own experience, I have arrived at the impression that the administration of insulin is the most efficient method. In general, the physical discomfort has been of less intensity and shorter duration and the nutritional state has been better with this method than in previous cases in which treatment was by the ordinary procedures. Limited material has not permitted me to check the results accurately against those that might be obtained in control groups with treatment

by other methods. It is highly desirable that one of the large hospitals for the treatment of persons addicted to the use of narcotics conduct such a controlled investigation.

CONCLUSIONS AND SUMMARY

Ten cases in which insulin was used to give relief from the symptoms attending withdrawal of morphine and heroin are reported.

The patients using heroin and those addicted to the use of larger doses of morphine responded less well to the treatment than did the other patients.

In general, the treatment was satisfactory, regardless of the type or quantity of drug used by the patient, and was more effective than the ordinary methods previously used by me in the management of such patients.

An important result accomplished with this method, in addition to the relief from physical discomfort, was the maintenance or reestablishment of an adequate state of nutrition.

The factor of suggestion was not considered important in obtaining a favorable response to the injection of insulin.

The majority of addicts to the use of morphine and heroin apparently comprise a nondiabetic group who tolerate unusually large quantities of insulin without the development of significant hypoglycemic reactions.

The excellent empirical results obtained by the treatment with insulin strongly suggest that a relationship, either direct or indirect, exists between addiction to morphine and carbohydrate metabolism.

News and Comment

NEW YORK HOSPITAL—WESTCHESTER DIVISION

The Governors of the Society of the New York Hospital announce that the name of Bloomingdale Hospital at White Plains, N. Y., has been changed to New York Hospital—Westchester Division in order to convey a clearer understanding than has heretofore prevailed of the relation of this hospital to the society by which it has been conducted since it was established in 1821. This seems especially advisable because of the great progress in the psychiatric work and facilities of the society at White Plains and the closer relations with the New York Hospital, 525 East Sixty-Eighth Street, New York., by the establishment there of the Payne Whitney Psychiatric Clinic. The governors also announce that Dr. Clarence O. Cheney, formerly director of the New York State Psychiatric Institute and Hospital and formerly professor of psychiatry at Columbia University, is now medical director of the Westchester Division.

FIRST INTERNATIONAL CONFERENCE ON FEVER THERAPY

The First International Conference on Fever Therapy, originally scheduled for the end of September 1936, has been postponed and will be held on March 30 to April 2, 1937, at the College of Physicians and Surgeons, Columbia University, New York. Invitations on behalf of the conference will be issued by the Department of State of the United States to ministries of public health of other countries. The medical departments of the Army, the Navy and the Public Health Service of the United States will be represented, as will also the New York City Department of Health and Department of Hospitals. A tour has been arranged to take place immediately following the conference, to enable physicians to observe the technics employed in fever therapy in some hospitals and medical institutions in the United States: the Strong Memorial Hospital of the University of Rochester, Rochester, N. Y.; the Henry Ford Hospital, Detroit; the Mayo Clinic, Rochester, Minn.; the Kettering Institute for Medical Research at the Miami Valley Hospital, Dayton, Ohio, and Northwestern University Medical School, Chicago.

Further information regarding the conference may be obtained from the general secretary, Dr. William Bierman, 471 Park Avenue, New York.

Abstracts from Current Literature

Anatomy and Embryology

THE DETERMINATION OF THE EYE IN THE ANURAN, HYLA REGILLA. ALTON L. ALDERMAN, J. Exper. Zoöl. **70**:205 (April) 1935.

In each experiment described a median rostral square of the anterior part of the medullary plate was taken from a neurula of Hyla regilla in an early stage of development and transplanted into the midventral wall of the belly of a neurula in a later stage. By underbedding the transplants, respectively, with substrates taken from various neighboring regions it was shown that the formation of the eye was definitely influenced by the locus and polarity of the substrate used; asymmetry, inversed polarity and partial cyclopia could be induced in the transplants as well as normal single or paired optic vesicles. It was concluded that at the time of operation partial determination had taken place in the medullary plate but that there existed a zone of inhibitive action in the substrate surrounding the eye-inducing area.

WYMAN, Boston.

CONTROL OF PIGMENT MIGRATION WITHIN THE CHROMATOPHORES OF PALAEMONETES VULGARIS. F. A. BROWN JR., J. Exper. Zoöl. **71**:1 (July 5) 1935.

All the movements of the pigments within the chromatophores of the shrimp, Palaemonetes vulgaris, are controlled by hormones, and each pigment is controlled by an independent hormone. Concentration of the white pigment is produced by a hormone formed in the eyestalks and in some tissue of the anterior region of the cephalothorax. Concentration of the red and the yellow pigments is produced by hormones formed in the eyestalks and in the central nerve organs. There is some evidence that a hormone is contained in the eyestalks which controls the blue pigment. Dispersion of the pigments may be explained by the absence of the pigment-concentrating hormones. The eyes are the only receptors involved in the responses of the chromatophore system of Palaemonetes.

WYMAN, Boston.

THE POTENCIES OF PORTIONS OF YOUNG CHICK BLASTODERMS AS TESTED IN CHORIO-ALLANTOIC GRAFTS. A. J. DALTON, J. Exper. Zoöl. **71**:17 (July 5) 1935.

Various transverse levels of the area pellucida from embryos in the broad primitive streak stage up to the stage of four somites were tested for developmental potencies by transplantation to the chorio-allantoic membrane. Levels from donors in all stages up to the definite primitive streak stage were tested with the hypoblast attached and with the epiblast alone. For transplantation, a platinum loop proved more satisfactory than tweezers, as relationships were less distorted and the occurrence of differentiation was more frequent.

In the absence of the hypoblast, grafts of the region anterior to the node differentiated into nerve tissue characteristic of anterior head parts. The epiblast of the region of the node field from early streak stages differentiated into specific nerve tissue and notochord. Axial mesoblast derivatives appeared only in such transplants from the definite primitive streak stage. The epiblast posterior to the node field did not form axial parts. The hypoblast is important in the formation of the axial mesoblast, which in turn is considered the typical inducing agent for the development of the central nervous system. In the presence of the hypoblast, axial structures are formed at transverse levels back to and including the second fourth of the streak, posterior to the node field. Neither node nor node field is essential to the differentiation of axial parts. The area capable of forming heart tissue is larger than the area presumptive for the organ, and the appear-

ance of liver in grafts is dependent on the presence of differentiating cardiac muscle. As regards the central nervous system and the intestinal tract, an anteroposterior arrangement of presumptive areas is indicated.

Embryonic segregation is considered to occur during primitive streak formation. The present study of the epiblast is a step in the direction to define precisely the relative importance of the subordinate parts of the embryo to the further segregation of potencies in previously established, less restricted segregates.

WYMAN, Boston.

THE EARLY DEVELOPMENT OF THE HYPOGLOSSAL MUSCULATURE IN THE CHICK. R. P. HUNTER, J. Morphol. **57**:473 (June 5) 1935.

In a study of the chick embryo it was found that ventral extensions from the third and fourth myotomes initiate the hypoglossal downgrowth in the embryo of twenty somites. Extensions from the last three occipital and the first cervical myotomes are present in the embryo of thirty somites. These processes subsequently form a condensed area below the second to the seventh myotome, which is termed the submyotomic tract. A cord of mesoderm, the hypoglossal downgrowth, develops ventrally from this area. The first, second, sixth and seventh myotomes have been termed indirect, and the third, fourth and fifth myotomes have been termed direct contributors to the hypoglossal downgrowth. The downgrowth extends ventrally to the pericardium and turns cephalomedially in the pharyngeal floor to become associated with the material in the anterior wall of the aortic sac, ventral to the thyroid anlage.

At the seventy-fifth hour of embryonic development the hypoglossal nerve has four occipital and two cervical roots, two of the occipital roots being lost later. A temporary connection of the third cervical root to the hypoglossal nerve is seen at the fifth day, but it disappears by the sixth day. At this time the first occipital root is reduced to a few fibers, the occipital roots from the second to the fourth increase in size and the first and second cervical roots join the hypoglossal nerve. The correspondence of the myotomes contributing to the hypoglossal cord and the nerves providing the major contributing roots of the hypoglossal nerve is commented on.

WYMAN, Boston.

THE DEVELOPMENT AND STRUCTURE OF THE EYES, OCELLI, OF THE FEMALE BLACK SCALE, SAISSETIA OLEAE BERN. W. S. MARSHALL, J. Morphol. **57**:571 (June 5) 1935.

The female black scale has a pair of lateral ocelli, each consisting of four parts: the lens, the vitreous body, the crystalline body and the retina. Their structure is similar in the fully developed embryo, in the first and second larvae and in the adult. Throughout the life of the scale insect they do not change, except in size, remaining as the visual organs of the adult, and in very old insects they appear to disintegrate. This disintegration begins with the inner surface of the lens and later extends to other parts of the organ. Each ocellus begins development as a disk of a few hypodermal cells, which enlarges, invaginates and forms a vesicle which is cut off from the hypodermis. The outer cells of this vesicle form the vitreous body, and the inner, larger group of cells form the retina. The vitreous body then forms a biconvex lens, and granules of yellow pigment appear in the retina, which later become dark brown or black. In the process of ecdysis the old lens is cast off, and a new one is secreted by the vitreous body. The nuclei of the embryonic retinal cells migrate to the proximal end of each cell and become the nuclei of the nerve fibers, one of which is attached to each retinal cell, or they disappear. Early in the first instar larva a mass of tissue appears between the vitreous body and the retina, which later forms the large, irregular crystalline body. A swelling at the base of the ocellar nerve where it connects with the brain has nothing in its structure to give it the appear-

ance of an ocellar ganglion, but two and possibly three areas within the brain near the origin of the ocellar nerve are seen which might be the ganglia supplying nerve fibers for the ocellus.

WYMAN, Boston.

THE EYE OF THE MONOTREME, ECHIDNA HYSTRIX. EDWARD BELLAMY GRESSER and CHARLES V. NOBACK, J. Morphol. **58**:279 (Sept. 5) 1935.

The histologic structure of the eye of the spiny ant-eater, Echidna hystrix, is described. The eye is small and is protected by nonciliated lids. It has no nictitating membrane and has heavy, dark brown iridic pigmentation. The posterior two thirds of the globe is cup-shaped, and the cornea is sharply curved. These characteristics favor the eyes of the majority of the avian species and of some of the piscine species. Embedded in the sclera is a complete cartilaginous cup, which is also seen on the eyes of piscine and avian species. Except for an anangiotic fundus, the structure of the retina and the shape of the lens are mammalian in character.

WYMAN, Boston.

Psychiatry and Psychopathology

BASAL METABOLISM IN CHILDREN OF NORMAL AND SUBNORMAL INTELLIGENCE. H. D. ROTHBART, Am. J. Dis. Child. **49**:672 (March) 1935.

Rothbart studied ninety-eight children, of whom fifty-nine were boys and thirty-nine were girls. He concluded that there was no relationship between the basal metabolic rate and the intelligence quotient. The intelligence quotient was determined by the Stanford-Binet test. He found that the basal metabolic rates of the boys appeared to be slightly higher than those of the girls, and he concluded that the metabolic rate of a boy may be as high as plus 15 per cent without evident abnormality. The values for the cholesterol and creatinine content of the blood did not show correlation with the basal metabolic rate. The values for cholesterol appeared to be slightly lower for the boys, and there was no apparent difference in the values for normal subjects as compared with children of subnormal intelligence. The blood pressure and the pulse rate in the majority of the children appeared to be directly proportional to the basal metabolic rate.

WAGGONER, Ann Arbor, Mich.

PSYCHIATRY AND THE PROBLEM OF DELINQUENCY. MENAS S. GREGORY, Am. J. Psychiat. **91**:773 (Jan.) 1935.

While psychiatry has much to contribute to the understanding of the individual criminal, it must be careful not to oversell itself. Gregory warns that this has already occurred and that intelligent laymen, annoyed at the overenthusiastic propaganda which would hold out psychiatry as a social cure-all, have become disillusioned about the scope and potentialities of the psychiatric field.

Gregory divides criminals who have appeared at the psychiatric clinic of the New York General Sessions Court into three types: (1) those who have exhibited a consistently satisfactory adjustment between instinct and the demands of reality and who have committed a crime under great stress, unusual opportunity or extreme circumstances—i.e., a relatively normal group; (2) those who periodically throw off their inhibitions and behave like persons with a real psychopathic personality but who react emotionally to their abnormal behavior so that they return to a fairly even readjustment—i. e., a "personality-deviate" group, and (3) those with true psychopathic personality. The last group is subdivided into several classes—the neurotic, the emotionally immature, the emotionally unstable, the nomadic, the inferior, the sexually abnormal, the schizoid and the paranoid.

Only 20 per cent of the relatively normal group were recidivists, while 30 per cent of the "deviates" were chronic offenders. On the other hand, 85 per cent of the psychopatic persons were recidivists. This disproportion was striking in the

robbery-burglary homicide group, but among offenders charged with simple larceny, without burglary or robbery the proportion of normal persons was much higher.

Gregory recommends a more intelligent method of grouping the inmates of custodial institutions. The effort to segregate first offenders from hardened offenders is a commendable start, but since the psychologic tendencies toward crime are not measured by the technical police record, an individual classification on a psychiatric basis would be superior to the classification on the basis of police records. It is also necessary to set up intermediate institutions, "near-jails" and "near-hospitals," to provide for the study and training of the psychopathic offenders who do not belong in the ordinary state hospital and who cannot be permitted to remain in the community.

DAVIDSON, Newark, N. J.

A CLINICAL STUDY OF INMATES SENTENCED TO SING SING PRISON FOR MURDER IN THE FIRST DEGREE. AMOS BAKER, Am. J. Psychiat. **91**:783 (Jan.) 1935.

A study of fifty prisoners in the death house at Sing Sing reveals that twenty-seven were apparently normal psychologically and psychiatrically and twenty-three showed some abnormalities. The latter group included persons suffering from drug addiction, excessive alcoholism, excessive neurotic tendency and severe head injury (one each), persons who were mentally deficient (four) and those with psychopathic personality (ten). The remaining five subjects in the abnormal group were of inferior intelligence, although not definitely defective. Only two of the fifty admitted guilt without any reservation. On admission most of the prisoners behaved well, without serious emotional instability, until the time for appeal drew near. At that time anxiety developed. If a new trial was granted, a gubernatorial pardon ordered or executive clemency shown, the prisoner acted "as if a great load had been lifted from him." Those denied clemency bore up surprisingly well.

Two of the fifty inmates were women. Fourteen of them came from broken homes, six were only children, one was a twin and three were illegitimate children. Most of the prisoners (twenty-eight) had failed to be graduated from grammar school. Only eleven had records of delinquency during childhood or early adolescence. A fourth of the inmates were excessive users of alcohol, but only one was addicted to the use of drugs. All but four of the fifty subjects were under the age of 40, and nineteen were under 21. A positive Wassermann reaction of the blood was found in eight cases. Only one prisoner was definitely psychotic, and none feigned insanity. In none of the cases did the strain of the residency in the death house precipitate a psychosis.

DAVIDSON, Newark, N. J.

CHRONIC POST-ENCEPHALITIS IN JUVENILE DELINQUENTS. MATTHEW MOLITCH, Am. J. Psychiat. **91**:843 (Jan.) 1935.

A clinical study of ten boys with a postencephalitic state who entered an institution for delinquent boys is reported. The ages ranged from 12 to 17. Four of the boys were Negroes. Four of the boys showed evidences of definite parkinsonism on neurologic examination, and in their cases the behavior problem was less severe than in the cases of the remaining six subjects. Each boy received individual psychiatric study. The intelligence quotients of the Negro boys were 58, 71, 76 and 92. Of the white boys, three had intelligence quotients between 70 and 80, one had a quotient of 84 and the other two had ratios of over 90. Two of the boys on subsequent retesting showed definite deterioration. All had a history of slow progress in school. Four showed somnolence, two were obese, two were uncontrollably impulsive, one was somewhat paranoid, one was a passive sodomist and three were markedly suggestible. It was necessary to individualize the treatment for these boys to a high degree, but in spite of this the group continued to present the worst problem in the institution.

DAVIDSON, Newark, N. J.

SEXUAL STERILIZATION: FOUR YEARS EXPERIENCE IN ALBERTA. C. A. BARAGAR, G. A. DAVIDSON, W. J. MCALISTER and D. L. MCCULLOUGH, Am. J. Psychiat. **91**:897 (Jan.) 1935.

In 1928 the Canadian province of Alberta passed its sexual sterilization act, in accordance with which 261 persons have been sterilized in the last five years. The operation performed is vasectomy or salpingectomy. The consent of the patient or his guardian is always obtained before the operation is permitted. Because of sterilization, many persons who would otherwise have been retained in confinement in institutions have been discharged. No fatalities, no serious surgical complications and practically no loss of libido have been reported following sterilization. In some cases, removal of the fear of pregnancy has heightened sexual satisfaction, and only in a few cases have patients reported any diminution in sexual pleasure.

Two thirds of the patients who were sterilized were mentally defective, and most of the remainder were psychotic or were convalescing from psychoses. Sixty-two per cent of the patients made good moral adjustments after discharge. In at least two instances sterilization had the effect of keeping together a family that would inevitably have been broken up if the fear of pregnancy had continued. There was no evidence that sterilization led to increased immorality. The authors believe that mentally defective persons should not be permitted to assume the responsibilities of parenthood for which they are so poorly adapted, and also that those who have suffered from mental breakdowns have the right to exemption from the burden of parenthood.

DAVIDSON, Newark, N. J.

A PROGRAM FOR THE DETERMINATION OF THE THERAPEUTIC EFFECTIVENESS OF THE PSYCHOANALYTIC METHOD. CLARENCE CHENEY and CARNEY LANDIS, Am. J. Psychiat. **91**:1161 (March) 1935.

For more than a quarter of a century the actual therapeutic value of psychoanalysis has been a matter of dispute. Cheney and Landis suggest a method whereby the success of psychoanalysis in treating patients with neuroses and psychoses may be evaluated. The objection cannot be made that the analytic method is an art rather than a science, for Freud himself repeatedly maintained that his technic is scientific; if so, it should be open to the usual scientific checks and verifications. Nor can it be contended that psychoanalysis is still too much in its infancy to permit experimental verification, for any method after forty years of intensive use should be well enough developed to permit scientific scrutiny.

The method proposed by Cheney and Landis consists in the selection of a group of neurotic and of psychotic patients by analysts as good subjects for the analytic approach; there should be at least 25 to 50 patients in each group. An equal number of patients should then be selected as a control group, the latter matching as nearly as possible the patients in the other groups age for age and diagnosis for diagnosis. Both experimental groups of persons should be institutionalized, and the physical care, hydrotherapy and other therapeutic measures should be identical for the two groups. The patients in the control group should receive no psychoanalysis and little psychotherapy; the patients in the other groups should be submitted to intensive psychoanalysis. Each patient and each control subject should be followed up for a number of years after the initiation of the treatment. Written statements of each patient's condition should be submitted by the analyst before treatment of the patients in the experimental group. After the conclusion of the experiment the mental health and state of all the subjects, both in the experimental group and in the control group, should be compared with each other and with the same patient's status before treatment. In this way the therapeutic effectiveness of psychoanalytic therapy can be evaluated and its indications and contraindications clearly defined.

DAVIDSON, Newark, N. J.

SEX FACTORS IN INTELLIGENCE. AARON J. ROSANOFF, L. M. HARDY, I. A. ROSANOFF and C. V. INMAN-KANE, J. Nerv. & Ment. Dis. **80**:125 (Aug.) 1934.

There is an excess of mental deficiency in males as compared with females amounting to 29.4 per cent. The authors became interested in the problem through the discovery of the contrast in the incidence of mental deficiency according to sex in 27 pairs of opposite-sex twins. Of 81 pairs of twins, both had mental deficiency in 34 instances, the male alone in 31 instances and the female alone in 16 instances. A study of 233 pairs of opposite sex twins of normal or superior intelligence in the Los Angeles public schools showed that there was a relative excess of persons with higher intelligence (as estimated by the Binet-Simon test), such excess amounting to 22.5 per cent. Further observation was made on 880 groups of siblings, 1,010 boys and 1,007 girls, in the Long Beach City schools; the average intelligence quotient of the boys was 105.6 and that of the girls 107.9. The authors found that there was a greater inferiority of intelligence quotient among later-born boys as compared with first-born boys than there was of first-born girls over later-born girls. The findings seem to bear out the contention that the first born as a group are somewhat handicapped in intelligence as compared with the later born.

The authors consider that many cases of both relative and absolute mental deficiency are produced by factors at work in the fetal period of life or during the process of birth. There is considerable evidence to indicate that male fetuses are more vulnerable than female ones, both generally and with respect to the cerebrum; hence a higher incidence of both relative and absolute mental deficiency in the male than in the female sex.

HART, Greenwich, Conn.

SOCIAL SERVICE PROBLEMS AMONG VENEREAL DISEASE CASES. ALBERT PFEIFFER, J. Social Hyg. **21**:157 (April) 1935.

A study of the records in the state health department of New York and of the various dispensaries of two upstate cities shows that over 50 per cent of patients with syphilis and gonorrheal infections in those cities are grouped in well defined areas: the crowded, unsanitary slums. In these areas there is also much tuberculosis. Given the morbidity rate of one of these diseases, the rate of the other can be estimated within 5 per cent. Thus, Pfeiffer thinks that elimination of the slums would be a great remedial factor in public health work and especially in the control of venereal disease. More patients are seeking treatment in the clinics of the state than formerly.

FERGUSON, Niagara Falls, N. Y.

MENTAL DISEASE AND THE ARMY. ELLEN WINSTON, Ment. Hyg. **19**:281 (April) 1935.

The incidence of mental disease in the peace time army of the United States is higher now (rate about 4 per thousand) than it was before the World War (rate about 1½ per thousand). This is probably due not so much to any emotional aftermaths of the war as to improved methods of diagnosis and more careful methods of classification. The rate per thousand fell from 5.3 in 1920 to 3.9 in 1931; so there has certainly been no increase in mental disease in the army since it was adjusted to a peace time basis. The incidence of mental disease is lower among officers than among enlisted men, although the incidence of psychoneurosis is higher among officers. The rate is likewise higher among soldiers serving in the Philippines than among the men serving in continental United States. More than half of the hospitalized mentally ill persons in the army have dementia praecox, a disproportion due probably to the youth of the enlisted men.

DAVIDSON, Newark, N. J.

BEHAVIOR PATTERN AND BEHAVIOR MORPHOLOGY. ARNOLD GESELL, Science **81**:15 (Jan. 4) 1935.

The essence of this article is: "At 24 weeks the infant contacts the pellet with pronate hand, in a pawlike manner, with no finger adjustments. At 28 weeks he flexes his fingers upon the pellet. At 32 weeks he grasps it by a simultaneous raking flexion. At 36 weeks he grasps it between thumb and index. At 40 weeks he approaches and contacts the pellet with extended index. He pokes and pries with his index. This poking projection of the index is a pattern characteristic so well defined that at 40 weeks it is almost as plain as the nose on his face. It is a new form of behavior, and like the profile of his nose, it is an intrinsic morphogenetic product."

The author is verbose and vague concerning "form." He states: "The form characteristics of behavior pattern can be investigated in their own scientific right." Of course they can, but the superfluous word "form" is dragged in here to support the following specious argument that such investigations have to do with "morphology." This term is used inaccurately and unjustifiably throughout the paper to indicate change of position, variation in sequence of muscular movements, behavior pattern, etc. Poetic license is all very well in its place, but in science terms must be specific. A dancing master may teach "good form," but that is no reason why departments of anatomy should take up choreography!

COBB, Boston.

A PSYCHOLOGIC STUDY OF A MENTALLY DEFICIENT CALENDAR CALCULATOR. GONZALO R. LAFORA, Encéphale **30**:309, 1935.

The lack of cooperation of the mentally deficient person makes it difficult to obtain information about the mechanism of such abilities as rapid calculation and memory for dates, names or unrelated events. Witzel reported the case of an imbecile, aged 22, who reduced all arithmetic operations to multiplications of 16, which she had memorized by placing buttons in groups of 16. Thus, she had found that $23^2 = 33 \times 16 + 1$ and $36^2 = 81 \times 16$. The aptitude for calculating dates was studied by Blin in an oligophrenic boy, aged 12 years, who could not do simple arithmetic but could tell without hesitation the day of the week of any date within the three years preceding and the year following the current one. When asked how he did this, he replied only: "Because I know." Following a suggestion of Binet, Piéron in this case found the reaction time shorter for dates close to the current time than for those more distant. He concluded that for the former simple memory was used and for the latter some simple operation. Dupain pointed out the existence of formulas used by professional calculators which could serve for a period of twenty years. But it was incredible that this young moron should know, let alone employ, such methods.

Lafora's case resembles the former. Its special interest lies in the aptitude and willingness of the subject to explain her modus operandi. The patient, a girl aged 15, became mentally retarded and epileptic after typhoid at 4 years. Her intelligence quotient was 65. In spite of schooling and a great desire for education, she could learn only by rote. She possessed a great mechanical memory for past events, dates, rules of grammar and multiplication tables but could not do simple arithmetic without a great many errors and was unable to solve such problems as the change-making tests of the Binet scale even when she could do the corresponding subtraction. She could calculate in from two to eight seconds the day of the week corresponding to any given date, or vice versa, within the three years preceding or the two years following the current year. Her reaction time was notably less than that of a professional calculator which the author had the opportunity of studying. "The essence of her procedure consists in her reliance, for each reply, on two or three coinciding data which are supplied by her mechanical memory. Through frequent repetition the mnemonic act is almost automatic and the data reach her imagination with great precision. These data are supported by rules of relation and coincidence which she has noted by the comparative study of the calendar

for several years—her favorite pastime since the age of 9." These are what Müller called the natural aids to memory. Thus, to choose from numerous examples given, she knows that January 1 of nonleap years corresponds to the same day of the week as October 1; that January 1 of any given year corresponds to a day of the week following that of the preceding year, save for leap years, which advance two days; that the months of 1931 were identical with those of 1925. Very little actual arithmetic is involved in such operations.

For comparison, the mechanisms employed by intelligent "memory artists" are described. The famous little shepherd, Henri Mondeux, studied by the Paris Academy of Sciences in the early nineteenth century, knew by heart the squares of all numbers up to 100. He had further discovered independently a number of rules, such as Newton's binomial theorem. To find the square 2,435, he separated that number into two lesser ones, 24(00) and 35. $2{,}435^2 = 24^2 + 2 \times 24 \times 35 + 35^2$, with the proper zeros added. As the values of 24^2, 24×35 and 35^2 were known by heart, the operation was reduced to a simple addition. Among the other examples given are the case of Canalejas, who could commit to memory rapidly enormous series of unrelated data; of Jaurès, who after a single reading could deliver one of his speeches translated into a language of which he was ignorant. The most extraordinary calculator was Dr. G. Rückle, himself a noted mathematician, studied by Müller and Kroh. Rückle could repeat a series of forty-eight numbers after a learning period of 44 seconds or seventy-two numbers backward after one hundred and thirty-seven seconds. He used such mnemotechnic devices as the facts that the side of a circumscribed dodecahedron is 0.535, that the first year of the reign of Cyrus was 559 or that the log of 13 is 1.86, all of which he knew by heart and employed to establish associations with otherwise unrelated numbers. All of these methods are fundamentally of the same order as that used by the mentally deficient calendar calculators, but on a different scale.

LIBER, New York.

A PROCESS FOR EVALUATING ABILITY TO LEARN. A. REY, Arch. de psychol. **24**:297, 1934.

Rey makes a strong point of the advisability of comparing persons for their ability to learn rather than for their accomplishment, noting that similarity in accomplishment or present performance may not mean similarity in mental ability if the persons in question are not comparable in their previous experiences. His test of the ability to learn consists of a series of three boards, each containing nine disks, all but one of which is movable. The subject has to learn to point correctly to the disk which is not movable. Rey gives norms for children, based on a study of eighty subjects, and compares the qualitative differences in performance at different ages. He then discusses certain qualitative characteristics of the learning ability of adults with various abnormal mental conditions. From the results obtained with the subjects studied he concludes that the test is better than the usual memory exercises in detecting abnormalities of memory in such conditions. He notes, however, that the test shows only one type of memory and that other tests should be devised for other types of memory, notably for memory for verbal material.

McBRIDE, Philadelphia.

Meninges and Blood Vessels

MENINGOCOCCIC MENINGITIS IN CHILDREN. JOSEPHINE B. NEAL, J. A. M. A. **105**:568 (Aug. 24) 1935.

Neal states that meningococcic meningitis in nonepidemic periods is essentially a disease of childhood. During epidemics and sharp outbreak, the age incidence is considerably higher. The clinical picture in older children follows closely that in adults. In the first and even in the second year of life, it is the author's impres-

sion that the fulminating type is rather uncommon, and so also is septicemia. The early symptoms in infants do not as a rule suggest an involvement of the central nervous system. The onset, while usually sudden, is not so abrupt as in older patients. There are many conditions and diseases in which signs and symptoms develop resembling meningitis. It can be determined whether or not meningitis is present only by a lumbar puncture and examination of the spinal fluid. If meningitis is present, the kind can be determined only by a cultural examination of the spinal fluid, except in the case of tuberculous meningitis. In this disease the diagnosis may be established by the demonstration in the smear of acid-fast bacilli. Every specimen of spinal fluid withdrawn should be completely examined. In purulent meningitis the cell count is of doubtful value. It is difficult to obtain a uniform mixture of the cells through the fluid, as the cells settle out rapidly, and if the fluid is collected in successive tubes there is a marked variation in the cell count in the different specimens. For these reasons comparisons of the cell count on succeeding days are likely to be of no value and even misleading. The value of serum in the treatment of meningococcic meningitis has been generally accepted for nearly thirty years. In spite of this there is still a wide divergence of opinion in regard to its proper administration. In Neal's experience the best results are obtained by moderation in the use of the serum. If the patient does not have the septicemic type with a positive blood culture, she thinks that serum should be administered only intraspinally. It seems likely that when too frequent lumbar punctures are done cells at the maximum of their fighting power are removed and the purpose of the treatment is defeated. It is her custom, whenever a lumbar puncture reveals a cloudy or hazy specimen of spinal fluid, to give antimeningococcus serum intraspinally at once. Further administration will depend on the examination of the spinal fluid, but all patients are treated on the assumption that they have meningococcic meningitis until some other organism is isolated. If block develops—complete or partial—the subarachnoid space must be drained and the serum administered either by cisternal or by ventricular puncture. If the fontanel is still open, ventricular puncture is to be preferred to cisternal, as it is safer and more effective, since the block may be high. Sometimes the block may be relieved by cautious injection of air, physiologic solution of sodium chloride or serum after lumbar puncture. After this method of treatment is begun, lumbar puncture should be performed at intervals to see whether the block has been relieved. In cases of the septicemic type, serum should be administered intravenously as well as intraspinally. Complications must be treated as they arise. Perhaps the only complication that can be successfully treated by serum is the purulent arthritis which occasionally develops. This usually subsides under symptomatic treatment, but in some instances it may be necessary to aspirate the joint and inject the serum. General treatment for meningococcic meningitis is the same as that for any severe acute infection. While the mortality in children of the first or even the second year of life is high, that between the third and the fifteenth year is less than for any other age group. The author emphasizes the importance of a conservative method of administering the serum. This opinion is based not only on her own experience but also on that in a number of hospitals in which this method has been used. EDITOR'S ABSTRACT.

CLINICAL MANIFESTATIONS OF SUBARACHNOID HEXORRHAGE. E. N. KOWALEV and K. W. SCHIMANSKI, Deutsche Ztschr. f. Nervenh. **137**:103 (June) 1935.

Within the last three years Kowalew and Schimanski observed 44 cases in which a clinical diagnosis of subarachnoid hemorrhage had been made. They call attention to three cardinal symptoms that characterize subarachnoid hemorrhage: headaches, meningeal manifestations and xanthochromia. In most cases the headaches are sudden, striking a previously healthy person like a sudden hard blow on the back of the head. The pain spreads quickly to other parts of the head, to the back of the neck and to the spine. The authors found this localization in

37 of the 44 cases observed. Rigidity of the muscles of the neck associated with the Kernig sign was observed in 43 cases. The rigidity reaches its height within the first twenty-four hours. In cases of severe involvement there may be relaxation of the entire musculature together with areflexia. These are the cases in which the prognosis is poor. Xanthochromia and increased pressure of the spinal fluid continue for about seven or eight days.

Less constant manifestations are changes in the psychic sphere. At the onset of the attack there may be stupor or loss of consciousness lasting from a few minutes to several hours. Loss of consciousness was observed in 38 per cent of the cases. Bradycardia was present during the acute stage. Vomiting was observed in 45 per cent of the cases. In 75 per cent a subfebrile temperature was noted as early as the second day of the attack, reaching its maximum (101.3 F.) in five or six days. The facial nerve was involved in 8 and the optic nerve in 6 cases. Retinal hemorrhage was found in 2 cases. The oculomotor nerve was involved in 2 and the abducens nerve in 3 cases. Anisocoria was noted in 50 per cent. The deep reflexes were often diminished, and in the lower extremities they were entirely absent in 70 per cent of the cases. The Babinski sign and paresis due to involvement of the pyramidal tracts were observed in 3 cases. The authors call attention to the fact that rigidity of the neck is noted before the Kernig sign appears; with recovery, the latter sign is the last to disappear, a fact which was noted previously by Hess. In 1 case the meningeal symptoms were absent and in another the symptoms developed gradually. In a few cases the parenchyma was primarily involved, the meningeal symptoms developing later.

The acute symptoms reached their height in two days and then gradually subsided. The meningeal symptoms persisted on the average twenty-seven days. In one case they lasted sixty and in another only nineteen days. The headaches are greatly relieved by lumbar puncture, but this procedure has no effect on the meningeal symptoms. The authors found their patients predisposed to further attacks. They also found that when excitability is an early symptom the prognosis is not favorable. When meningeal symptoms are not present a fatal ending may often be expected.

Manifestations of residual symptoms ordinarily are unimportant. In 2 patients a mild headache persisted after discharge from the hospital. One patient was left with a peripheral facial paresis which was slow to recover.

The etiologic factors are many. Subarachnoid hemorrhage occurs more frequently in younger people. The authors found the majority of their patients to be of middle age or presenile. Goldflam found 10 of 13 patients under 30 years of age. The authors noted only 5 between the ages of 20 and 30. Arteriosclerosis plays a significant part in subarachnoid hemorrhage, being present in 43.2 per cent of the authors' cases. Arteriosclerosis was present in only 23 per cent of Symmond's 124 cases. Aneurysm accounted for 8 per cent and syphilis for 7 per cent. Biemond and Braak and others considered aneurysm of the cerebral blood vessels as the etiologic factor in subarachnoid hemorrhage. The authors do not consider subarachnoid hemorrhage a nosologic entity.

As for therapeutic measures, the authors are of the opinion that a careful lumbar puncture with removal of a small quantity of fluid is beneficial, and in cases in which the symptoms point to an increase in the intracranial pressure, repeated lumbar puncture is indicated.

BERNIS, Rochester, N. Y.

BENIGN CYSTS OF THE CEREBELLUM. D. O. VASILIU, Ann. Surg. **101**:347 (Jan.) 1935.

Two cases of benign cyst of the cerebellum are reported. In one multiple duodenal ulcers were noted at necropsy as a complication. Benign cyst of the cerebellum is exceedingly rare, and the diagnosis can be certified only after a careful microscopic examination of the wall of the cyst. The treatment is surgical.

GRANT, Philadelphia.

STRIATAL EPILEPSY. A. ROUQUIER, Encéphale **30**:338, 1935.

Intermediate between epilepsy and convulsive hysteria there exists a type of convulsion, of functional origin, in which, however, suggestion plays no part. Such seizures are therefore not hysterical. Rouquier has observed them associated with various syndromes connected chiefly with lesions of the striate bodies: myoclonus epilepsy, parkinsonian tremor or encephalitis. A case is reported.

A soldier, aged 21, was hospitalized for convulsions of a hysteroid type. The familial and the personal history were irrelevant. The convulsions could not be influenced in any way by suggestion and therefore were not hysterical. Neurologic examination revealed a generalized, fine tremor, predominating in the upper and lower limbs of the right side. The tremor disappeared on voluntary effort and was intensified by emotion, cold and fatigue, notably by a fatiguing test posture. When the latter was sufficiently prolonged the tremor gave way to a convulsive seizure. In the production of this type of seizure, just as in true epileptic fits, emotion undoubtedly played a part. The patient's seizures presented some features of hysteria, such as rolling on the floor and avoiding collisions with objects in his path, but there were also some features of true epilepsy, such as a postconvulsive crepuscular state.

The observations are of medicolegal importance, for these patients are often considered hysterical, and in compensation cases the real diminution of the capacity for work is systematically underestimated.

LIBER, New York.

MENTAL PHENOMENA IN CASES OF CEREBRAL TUMOR. ANTONIO CAMPANA, Riv. di pat. nerv. **45**:87 (Jan.-Feb.) 1935.

From a study of forty-two cases of tumor of the brain in which the presence of the growth was confirmed at autopsy, Campana concludes that mental retardation accompanies the development of almost all tumors of the brain and that this symptom in itself should lead one to consider a probable diagnosis of tumor. It is not possible to localize tumors of the brain by the mental symptoms alone. As for the pathogenesis of the mental symptoms in the course of tumor of the brain, the author accepts the belief that the mental manifestations are the result of the toxic action of the neoplasm.

FERRARO, New York.

NARCOLEPSY AND CATAPLEXY. O. GALLOTTI, Arq. brasil. de neuriat. e psiquiat. **16**:1 (May-June) 1933.

Gallotti thinks that it is advisable to designate hypnic crises without cataplexy as narcolepsy and associated hypnic and cataplectic crises as a combination of narcolepsy and cataplexy. Oneirism, probably as an equivalent of sleep attacks, is frequent in patients with narcolepsy or cataplexy. Geloplegia, also called gelolepsy of Lachschlag's type, probably is a larval form of cataplexy. Narcolepsy and cataplexy, alone or together, originate from several causes, some of which are still unknown. The pathogenesis of the group of idiopathic forms of narcolepsy is still hypothetic in spite of the progress in the technic for examination and diagnosis. The treatment should be directed against the cause of the condition in the symptomatic forms of narcolepsy and against the symptoms in the idiopathic forms.

EDITOR'S ABSTRACT.

A NEW SYNDROME IN THE DIAGNOSIS OF TUMOR OF THE CORPUS CALLOSUM. J. MICHELSEN, Deutsche Ztschr. f. Nervenh. **137**:152 (June) 1935.

In 1931 Brouwer and Biemond reported three cases of tumor of the corpus callosum with the following clinical symptoms: (1) marked psychic disturbance, (2) fever and (3) xanthochromia, with marked pleocytosis and an increase in the albumin content of the spinal fluid. Michelsen reports seven more cases of tumor of the corpus callosum with a similar symptomatology. In six the tumor was

verified at autopsy and in one by operation. The author found apraxia a less constant symptom because of the severe psychic disturbance which is regularly present in these patients.

In the first of the seven cases which Michelsen describes the symptoms first appeared three months before the patient came under observation. They began with headaches, attacks of loss of consciousness and changes in character. Examination disclosed severe psychic disturbances, general catatonia, negativism and mania. There were mild rigidity of the neck, choked disks, paresis of both abducens nerves, tremor of the hands and a tendency to fall backward. The spinal fluid showed increased pressure and xanthochromia, with pleocytosis and an increase in the albumin content. The temperature was increased. Autopsy disclosed a glioma with a hemorrhage in the corpus callosum. The symptomatology in the other six cases did not differ much from that in the first case. Michelsen found the aforementioned triad present in all seven patients.

Psychic disturbances vary from case to case. They are present in 95 per cent of cases, appear early in the disease and progress rapidly. Their pathogenesis is obscure. The corpus callosum connects the two cerebral hemispheres, and it can be assumed that it also associates the conceptions and ideas taking place in the hemispheres. When it becomes diseased, as in the case of a tumor, psychic disturbances often take place. Phylogenetically, the corpus callosum presumably possesses some psychic function, since animals without this commissure are psychically of a lower grade.

The cause for the increase in temperature has not been determined. The fever is not the result of infection. Aseptic fever is observed in cases of hemorrhage as a result of the decomposition of the red cells or of other cellular elements, and in cases of destruction and softening of large areas of the brain. Although so far temperature-regulating fibers have not been found in the corpus callosum, Michelsen points out that this commissure is a close neighbor of the corpus striatum and of the lateral ventricles. A tumor spreading from the corpus callosum, therefore, will invade the corpus striatum and the lateral ventricles. Injury to the corpus striatum has been known to produce fever. In addition, tumors of the corpus callosum are malignant, may grow bilaterally, and may attack both corpora striata. There is no definite method by which one can determine whether fever is of central origin or is caused by infection, except that patients with the former type feel relatively well, and the pulse and respiratory rates remain normal. Kroll recently found that in fever of central origin the temperature of the skin does not rise proportionately to that of the body as it does in fever due to infection.

Michelsen found xanthochromia in all the specimens of spinal fluid examined. When ventricular puncture discloses xanthochromia in one ventricle, it may be concluded that the seat of the tumor is near a ventricle. The pleocytosis is also to be explained on the basis that the tumor is in the neighborhood of a ventricle. This is especially true in cases of malignant tumor of the corpus callosum when softening and hemorrhage take place and there is an exudation of white cells, which eventually find their way into the fluid. BERNIS, Rochester, N. Y.

CLINICAL AND CHARACTEROLOGIC STUDIES IN PATHOLOGIC INTOXICATION. HERBERT BINSWANGER, Ztschr. f. d. ges. Neurol. u. Psychiat. **152**:703 (May) 1935.

Binswanger surveys and analyzes the available clinical material on pathologic intoxication in the records of the psychiatric clinic at the University of Zurich from 1894 to 1933. There were 174 cases, 168 in males and 6 in females; 140 of the patients were admitted once, 13 twice and 3 three times for the same condition. Most of the patients were between the ages of 20 and 30. Ninety per cent of the patients possessed psychopathic personalities, and the conclusion is reached that psychopathy is probably the most important predisposing factor. In 9 cases there was a history of injury to the head; 6 patients were schizophrenic, and 3 were mentally defective. There was 1 case each of epilepsy, exhaustion and organic disease of the brain. There was no constant relation to occupation. Only

20 per cent of the patients admitted were from Zurich and its environs. The condition was diagnosed correctly on admission only 51 times. Hereditary predisposition is probably a significant etiologic factor, though more material is needed for a definite conclusion to be reached.

Definite chronic alcoholism was present in 125 cases. An attack was precipitated usually by the consumption of a large amount of alcohol. In 6 cases of chronic alcoholism the onset followed the imbibition of only small amounts of alcohol. In 20 cases the onset followed the drinking of large amounts of alcohol, though no history of chronic alcoholism was present. In 123 cases the pathologic intoxication appeared while the patient was definitely intoxicated.

Binswanger describes three clinical variants of this disease. The most common is what he calls the epileptoid syndrome, of which there were 159 cases. The mental changes are of very brief duration. Usually the patient is aggressive and dangerous. There is always complete amnesia for the attack. The second type is the so-called delirious episode, of which there were 21 cases. The mental changes in this type are characterized by the presence of severe motor restlessness with delusions, hallucinations and marked anxiety. Aggressiveness and assaultiveness are not present in these cases. The third type is called the transitory alcoholic psychosis, of which there were 7 cases. This is a rather poorly delimited type, of longer duration, during the course of which there is usually a mixture of epileptoid and delirious features. Protracted confusion and catatoniform-like states are also observed. The diagnosis of this type of pathologic intoxication is extremely difficult.

Binswanger is unable to confirm the generalization of previous investigators who found pupillary rigidity during pathologic intoxication. He emphasizes the difficulty of examining the pupils during periods of severe motor excitement and points out that occasionally a patient was admitted while under the influence of a mydriatic drug. In this series pupillary rigidity was found in 6 cases. The pupillary responses were intact in 105 and sluggish in 24. Anisocoria was present in 4 cases.

In 87 cases a psychic trauma immediately preceded the onset of the mental symptoms. This was usually in the nature of a violent quarrel in the home or in a gambling house. Seventeen of the patients were under some unusually protracted psychic stress, such as difficult examinations. In 13 cases there was prolonged unemployment. In 12 cases there were love problems. In 12 cases the attack came on after paroxysms of vomiting associated with drinking. Three patients went to bed drunk and woke up with severe mental changes. In 5 patients there were rather complex affective disturbances.

In 122 cases there was complete amnesia for the behavior during the episode of mental change. In 45 there was insular or partial amnesia. In only 1 of the cases of the series was there no amnesia. While amnesia is usually present, it is not pathognomonic.

Twenty-six of the admitted patients committed crimes. Seven of these resisted an officer, 3 committed assault, 2 committed manslaughter, 3 attempted murder and 1 committed murder, 3 arson, 1 burglary and 1 sexual assault. Five of the patients threatened to commit a crime.

Binswanger mentions 1 patient who three years before had had an electrical injury followed by epileptic convulsions. After drinking he noted that some one stole some money from him. He became very excited and assaultive. Binswanger concludes that severe electrical injury can predispose to pathologic intoxication.

The difficulty in differentiating pathologic intoxication from other abnormal toxic states is noted, and the importance of amnesia is emphasized. The practical importance of such differentiation is due to the fact that patients are not responsible for their acts during states of pathologic intoxication, while the law recognizes some degree of responsibility during other states of excitement or confusion of an alcoholic nature. Diagnostic difficulties are presented by states of excitement in

persons with chronic alcoholism; by hysterical seizures in persons with a previous history of a tendency to the development of conversion hysteria, and by states of excitement with negativistic attitudes in mentally defective persons after excessive use of alcohol.

Laboratory studies showed evidence of disturbed hepatic function only in the persons who suffered from chronic alcoholism. There was no evidence that hypoglycemia is the cause of the abnormal mental state. There was no constant increase in the alcoholic content of the blood.

The frequency of psychopathic patients of low mentality in this series is noted. The importance of their inability to inhibit and control impulses is emphasized. The so-called asthenic motor type is more liable to such explosive emergence of primordial impulses with severe clouding of the sensorium. The neuropathic predisposition associated with alcoholic excess does not always result in pathologic intoxication.

SAVITSKY, New York.

Peripheral and Cranial Nerves

GLOSSOPHARYNGEAL NEURALGIA. M. M. PEET, Ann. Surg. **101**:256 (Jan.) 1935.

A survey of the literature concerning glossopharyngeal neuralgia has been made, and fourteen personally observed cases are reported. Twelve of the patients were operated on. In all cases, with one exception, the neuralgia was unilateral. Five cases were apparently unique in that there were both glossopharyngeal neuralgia and trigeminal neuralgia on the same side. In two of these cases the trigeminal neuralgia involved only the first and second divisions of the nerve. In the other three cases one patient had pain in the third division, one in the second and third divisions and one in all three divisions. No mistake in diagnosis seemed possible in any of these cases and certainly not in those in which pain was felt in only the first and the second division. The patient with bilateral glossopharyngeal neuralgia also had trigeminal neuralgia in all three divisions on one side. The results of operation were entirely satisfactory, all the patients being permanently relieved. None noticed the loss of sensation in the distribution of the ninth nerve. It is believed that intracranial section of the ninth nerve is the procedure of choice.

GRANT, Philadelphia.

PERIPHERAL NEURITIS CAUSED BY PROLONGED USE OF DINITROPHENOL. J. ERNEST NADLER, J. A. M. A. **105**:12 (July 6) 1935.

Nadler deals with late or delayed cases of poisoning by di-nitrophenol. The report is based on the study of twenty-two persons who took alpha-di-nitrophenol (1, 2, 4). Fifteen were seen in private practice and the remainder in the wards of the Bellevue Hospital. Sixteen showed no deleterious effects from the use of the drug; a rash developed in three of the remaining six patients, loss of taste in one and peripheral neuritis in two. The six patients showing toxic symptoms were taking the drug for obesity, and their history did not include allergy, neuritis, arthritis, alcoholism, diabetes, tuberculosis or disease of the liver or kidneys. Loss of the sense of taste as a result of intoxication by di-nitrophenol developed in one patient after she had been taking the drug for thirty-six days. This loss was complete for "sweet," "sour," "salt" and the like, and she experienced a "coppery" taste in her mouth at all times. She was not anesthetic to epicritic and protopathic stimuli, i. e., to light touches, pinpricks and heat or cold. The sense of smell was unimpaired. The administration of the drug was not stopped, and the patient's sense of taste gradually returned to normal in a month. The two cases in which peripheral neuritis developed following prolonged use of this drug are reported in some detail. These patients were on a diet containing adequate amounts of the vitamin B complex. They showed very striking sensory symptoms but no motor or trophic disturbances. The condition started in the toes, with various

disturbances of sensation, such as prickling, numbness and pain. Paresthesia persisted long after its original cause had been removed. This delayed poisoning is due to repeated exposure to small amounts of di-nitrophenol and not to an accumulation of the drug in the body.

EDITOR'S ABSTRACT.

PAROXYSMAL NEURALGIC TIC AS A SEQUEL OF TRIGEMINAL NEURITIS. WILFRED HARRIS, Brit. M. J. **1**:1112 (June 1) 1935.

Harris prefers to designate paroxysmal neuralgia of the trigeminal nerve which is not due to lesions of the nerve as tic of the trigeminal nerve, in order to distinguish it from atypical neuralgias, migraine, etc. However, tic of the trigeminal nerve may occur in cases of tumor, disseminated sclerosis and zoster along the trigeminal nerve. He reports three unusual cases in which anesthesia of the trigeminal nerve appeared suddenly and after from several weeks to four years completely disappeared only to be followed by typical tic of the trigeminal nerve, which yielded to injections of alcohol. Symptoms of this form of tic have been known to usher in chronic spastic paraplegia, especially disseminated sclerosis. Anesthesia of the trigeminal nerve may occur in cases of disseminated sclerosis. Harris believes that in his cases later complication by disseminated sclerosis seems unlikely because of the unusual history and the duration of the symptoms. He suggests classifying them in a separate group. A lesion in the sensory root of the trigeminal nerve may be the underlying condition, analogous to retrobulbar neuritis.

MALAMUD, Ann Arbor, Mich.

Treatment, Neurosurgery

THE SURGICAL MANAGEMENT OF CHRONIC SUBDURAL HEMATOMA. CHARLES H. FRAZIER, Ann. Surg. **101**:671 (Feb.) 1935.

The histories in six cases of subdural hematoma are presented, and it is apparent at once that there is great variation in many of the factors associated with this lesion. In three of the cases the condition should be designated as "chronic" (three, four and seven months' duration); in one, as "subacute" (twenty-five days' duration), and in two, as "acute" (only two weeks' duration). In three cases trauma was a factor; in one a pachymeningitis may have been the predisposing factor. The outstanding symptom common in all cases was headache; next in importance was somnolence, which was present in five cases. Inequality of the pupils was observed in three cases and advanced choking of the disks in one. Three of the hematomas were bilateral, and three were unilateral. In three of the cases there were symptoms of a focal nature. In one case the symptoms referable to the pyramidal tract were homolateral. In five cases the collection of blood was in liquid form and could readily be removed by suction; in one case the clot was partially organized. In every case the characteristic newly formed membrane could be seen; in three this was removed. In three cases the lesion was dealt with through an osteoplastic opening; in three, with dual perforations. In two a ventriculogram was made, and in one an encephalogram for the purpose either of making the diagnosis or of localizing the tumor. In three cases the diagnosis was made with the aid of cranial perforations. In three the symptom complex suggested a lesion of the frontal lobe. In two cases the symptoms were regarded as suggestive of tumor. In one case the diagnosis was hematoma or tumor; in one, hematoma or abscess, and in two, hematoma. Papilledema was a conspicuous feature in only one case; blurring of the disks was observed twice, and in three cases the disks were normal. Inequality of the pupils was observed in three cases. All the patients were males, the youngest being 13 years of age and the eldest 64. Five patients recovered. The single fatality might be ascribed to an error in judgment. Dual cranial perforations should be accepted as the method

of choice to establish the diagnosis, to determine whether the lesion is bilateral and to evaluate the hematoma. In the exceptional case in which the clot is well organized it may be necessary to reflect an osteoplastic flap.

GRANT, Philadelphia.

PROPHYLACTIC VACCINATION AGAINST INTRACRANIAL COMPLICATIONS FOLLOWING PNEUMOCOCCUS TYPE III MASTOIDITIS. JOSEPH L. GOLDMAN, GREGORY SHWARTZMAN and CECELE HERSCHBERGER, Arch. Otolaryng. **21**:154 (Feb.) 1935.

Complications are frequent in cases of mastoiditis due to pneumococcus type III (formerly called Streptococcus mucosus or Pneumococcus mucosus). Goldman and his co-workers conceived the idea of immediately vaccinating all patients with mastoiditis of this type. They used a stock vaccine for the first dose to save time and followed this with doses of autogenous vaccines. When the serologic reactions were inconclusive, they resorted to injections into a mouse, followed by cultures from its blood. They gave six biweekly injections. When the dose was more than 0.2 cc. they administered the vaccine by injections of small amounts at several sites. The vaccine contained 600,000,000 pneumococci type III per cubic centimeter. During a period of about three years they have used this procedure for twenty-five patients, only one of whom died. A study of the records of twenty-two patients with mastoiditis due to pneumococcus type III, who had been in the hospital at a previous time, revealed that five had died. However, the authors call attention to the facts that the number of cases is too small for one to draw any definite conclusion and that their studies of agglutinin, precipitin and complement-fixation reactions failed to show any increase in antibodies. The results of mouse protection tests have been inconclusive.

HUNTER, Philadelphia.

ON THE ACTION OF CERTAIN DRUGS IN SCHIZOPHRENIA. H. C. BECCLE, J. Ment. Sc. **81**:46 (Jan.) 1935.

Beccle believes that certain groups of schizophrenic psychoses depend to a great extent on dyscrasia of the endocrine system, particularly of the gonads. Thirteen patients, four female and nine male, were treated with endocrine preparations. Each male patient was given a tablet containing 1/13 grain (0.005 Gm.) of yohimbine hydrochloride combined with 1 grain (0.065 Gm.) of testicular extract; in cases of obesity, ½ grain (0.032 Gm.) of dry thyroid extract was added. At first this was given orally, but later, subcutaneously. The four females received 25 Allen-Doisy units of estrogenic substance and 1 grain of an extract of the anterior lobe of the pituitary gland, together with 1/13 grain of yohimbine hydrochloride, twice daily hypodermically. Most of the patients began to show changes after two months of treatment. Of the thirteen patients so treated, three of the female subjects were discharged as recovered, while the condition of the fourth was made definitely worse. Of the nine male patients, one showed no change, another showed slight improvement and seven were discharged. The total rate of recovery in this series was approximately 70 per cent. Yohimbine was given because it is a tonic and an aphrodisiac.

KASANIN, Howard, R. I.

DINITROPHENOL IN DEMENTIA PRAECOX. ISIDORE FINKELMAN and W. MARY STEPHENS, J. Neurol. & Psychopath. **15**:230 (Jan.) 1935.

Twelve female patients with dementia praecox of the hebephrenic type were treated with di-nitrophenol, a metabolic stimulant. The usual chemical changes in the blood, the loss of weight and an average increase of 37 per cent in the consumption of oxygen after four weeks of treatment were noted. Five of the patients showed improvement in the mental condition, but the increased attention given during the treatment could not be eliminated as a factor in this change.

SPERLING, Philadelphia.

LYSATE THERAPY. N. A. SCHERESCHEWSKY, Rev. franç. d'endocrinol. **13**:37 (Feb.) 1935.

This article is a general discussion of the subject of lysates. Most of the experimental work reported was carried out in the Experimental Institute of Endocrinology in Moscow under the leadership of Touchenoff. Histolysates, as lysates are otherwise called, are preparations made from endocrine glands by means of acid hydrolysis and peptic fermentation. The product thus obtained is not supposed to cause anaphylactic phenomena when given intravenously. It is not entirely clear whether the action of lysates is hormonal. According to Touchenoff, the lysates have an action of their own, independent of the hormones, which is in the nature of a stimulation caused by the specific quality of the products of disintegration. However, in experiments with the lysate of the thyroid gland carried out by other investigators in man and in tadpoles it gave reactions similar to those caused by thyroid preparations, and the lysate of the posterior lobe of the hypophysis had the same effect on persons with diabetes insipidus as the hormone of the gland. Certain lysates seem to act immediately, while the effects of others, such as those of the genital glands, are delayed. While the hormones of the genital glands do not cause immediate eroticism, this phenomenon is usually observed after the administration of the lysate of the genital glands. Some lysates contain no trace of hormones; the lysate of the pancreas, for instance, has no effect on diabetes. According to Touchenoff, the introduction of glandular products of disintegration causes a stimulation of the functionally homologous tissues. This led him to the hypothesis that the therapeutic action of the lysates is in the nature of a therapeutic stimulation or irritation, while that of the hormones is due to the additional mass of the specific hormones in the organism. It is questionable, according to Schereschewsky, whether lysates are capable of regenerating atrophied glands; prolonged treatment, for instance, of eunuchoid persons with lysates of genital glands produces only a slight improvement in the general condition and a very mild eroticism. Of interest is the rapid eroticism of men after the administration of lysate of the female genital glands. This observation would seem to belie the assertion that lysates usually act on the homologous organs only. The author believes that the action of the lysates is due to the various substances they contain, especially the albuminoid products, the halogens, lipins and colloids, and probably also the hormones.

NOTKIN, New York.

A NEW TREATMENT FOR CEREBRAL HEMORRHAGES AND ITS EFFECTS. R. COLELLA, and G. PIZZILLO, Riv. di pat. nerv. **45**:116 (Jan.-Feb.) 1935.

Basing their studies on numerous cases of tumor of the brain and of cerebral hemorrhages, embolism and thrombosis, Colella and Pizzillo reach the conclusion that it is possible to treat the focus of cerebral hemorrhage by the use of intramuscular injection of the patient's own blood. The technic consists of injecting from 25 to 30 cc. of citrated blood removed from the patient's veins into the gluteal region of the normal side. The sooner the injection is made, the sooner favorable results are obtained. Such treatment, which applies to cerebral hemorrhage of various kinds, is particularly indicated as a preventive treatment in cases of arterial hypertension. The injection of blood is followed by rapid lowering of the vascular intracranial pressure. Hemotherapy may be of help in establishing a method for the differential diagnosis between cerebral hemorrhage and softening, since it has no beneficial effect in the treatment of cerebral softening.

FERRARO, New York.

FURTHER RESULTS IN THE TREATMENT OF MANIA WITH ATROPINE SULFATE AND IN THE TREATMENT OF MELANCHOLIA WITH ERGOTAMINE. KARL LEONHARD, Ztschr. f. d. ges. Neurol. u. Psychiat. **151**:331 (Nov.) 1934.

Leonhard injected ergotamine subcutaneous'y into quiet, inhibited, depressed patients. Atropine sulfate was administered orally to manic, excited patients.

Fifteen were reported as improved or recovered and fifteen as unimproved after treatment with ergotamine. Twelve were reported as improved or recovered and five as unimproved after treatment with atropine sulfate. In a considerable number of patients, therefore, either improvement or recovery occurred. Nausea, vomiting and inability to cry were considered good prognostic signs in the depressed patients.

MICHAELS, Boston.

Special Senses

A NEW THEORY OF BINOCULAR VISION. F. H. VERHOEFF, Arch. Ophth. **13**:151 (Feb.) 1935.

This paper is a detailed study of experimental work relative to binocular vision. As corresponding retinal points are represented separately somewhere in the brain, each of every pair is represented in consciousness by the same single unit. This conscious unit can receive the stimulus from only one retinal unit at a time; when it receives the stimulus from one it excludes the stimulus from the corresponding unit. The term "replacement" is suggested for the process by which, in consciousness, stimuli from one eye are thus substituted for those from the other eye. The controlling factor in this process is attention. For individual retinal units replacement is always totally complete, but for retinal images it may be complete or incomplete, according to the number and distribution of the unit stimuli from one eye that are completely excluded. Replacement has one important restriction, namely, that it cannot reverse the relation of a conscious image to its contiguous background unless this reversed relation already exists between one of the retinal images and its own background.

For the seeing of two corresponding images as one, the term "unification" is suggested. The terms "fusion" and "suppression," as applied to vision, are misnomers and should be abandoned. True unification is accomplished by the complete or partial replacement in the conscious image of one retinal image by its corresponding image. When the two retinal images are nearly alike, the conscious image has a nearly constant value, which is nearly the same as that of each retinal image seen with one eye occluded. When the two retinal images differ in intensity or color, the attention and therefore the replacement may fluctuate (rivalry). It is impossible to compare accurately a binocular with a monocular image, because it is impossible certainly to exclude binocular vision.

So-called fusion of disparate retinal images does not occur, but it seems to occur when two similar disparate images produce the effect of depth and one of them disappears by replacement. It is suggested that this process be termed "quasi-unification." In the stereoscopic perception of depth, quasi-unification generally occurs, but depth perception is possible when both of any pair of disparate images are visible. Two disparate images, as projected on the horopter, appear about half the distance apart when seen stereoscopically as they do when seen in binocular simultaneous vision. When a disparate image disappears during stereopsis the position of its fellow remains unchanged. Which of two disparate images disappears is primarily determined chiefly by the effective attention values of the images and of the portions of the backgrounds corresponding to the latter.

Since in stereoscopic vision one of each pair of disparate images can be and generally is invisible, since crossed cannot be consciously distinguished from uncrossed disparate images and since binocular fixation can occur when one of the images fixed is invisible, it is evident that the process on which stereoscopic perception of depth depends cannot be consciously recognized.

Since somewhere in the brain corresponding retinal images must be represented separately and there is good reason to believe that in the occipital lobes they are so represented, it seems possible that in this region is chiefly situated the sensory nervous mechanism for stereoscopic perception of depth.

SPAETH, Philadelphia.

THE AFFERENT PATH OF THE LIGHT REFLEX. H. W. MAGOUN and S. W. RANSON, Arch. Ophth. **13**:862 (May) 1935.

This article presents an exhaustive review of the literature on the afferent path of the light reflex. Theories based on the clinical observation of lesions in the central nervous system as well as on considerable anatomic work are included. It is clear from a survey of all the evidence which the authors could collect and analyze that sufficient data are at hand to permit a reconstruction of the afferent course of the pathway of the pupillary light reflex. This pathway seems to run centrad in the optic tract and the superior quadrigeminal brachium to the pretectal region. From the pretectal region it swings ventrally around the central gray matter enclosing the rostral end of the cerebral aqueduct to reach the oculomotor nucleus. The pathway undergoes a partial crossing in the posterior commissure and another somewhere ventral to the central gray matter. The evidence is clear that no part of the superior colliculus is concerned with the pupillary light reflex. The question whether special elements in the optic system subserve the activity of the light reflex is still uncertain. SPAETH, Philadelphia.

INFLUENCE OF THE MIDDLE EAR ON LABYRINTHINE PRESSURE. HEINRICH KOBRAK, Arch. Otolaryng. **21**:547 (May) 1935.

The opinion that the labyrinth maintains a constant static pressure is based on the fact that the majority of investigations have been made by histologic methods. Kobrak, by the use of physiologic methods, studied the relationship between intracranial pressure, labyrinthine pressure and pressure in the middle ear. Certain clinical and experimental considerations are quoted which have led to the opinion that no communication of static pressure is present between the middle ear and the inner ear, resulting in the following dictum in Denker and Kahler's handbook (Handbuch der Hals- Nasen- Ohrenheilkunde, Berlin, Julius Springer, 1926, vol. 6, p. 458). "There seems to be no increase of pressure in the labyrinth worth mentioning during temporary increase of pressure in the middle ear, for instance during coughing or sneezing, because of the described anatomical conditions." The authors of the chapter from which this quotation is taken stated that there is only one type of movement for the intralabyrinthine fluid, that is, the acoustic oscillations of the fluid between the two windows induced by the pressure and suction movements of the foot-plate of the stapes. In other respects the fluid of the inner ear is compared to "stagnant water."

The delicate movements of fluid in a manometer inserted into the posterior vertical semicircular canal were cast on a screen and photographed. The results of these experiments do not agree with the former opinion. They show that intralabyrinthine pressure varies with every change of pressure in the middle ear and with every change of intracranial pressure. It was found that such a small change in pressure as 2 cm. of water produced an excursion of 0.2 cm. of the image of the meniscus on the screen, indicating that 0.02 cm. of fluid had been displaced.

According to Kobrak, when the displacement of labyrinthine fluid due to a change in the pressure in the intracranial cavity was compared with that due to a change in the pressure in the middle ear, it was found that it was much easier to create a movement of the labyrinthine fluid from the middle ear. The threshold for change of pressure in the middle ear was 0.3 cm. of water; whereas in the intracranial cavity it was from 10 to 15 cm. of water. It is assumed that any considerable movement of the labyrinthine fluid caused by a change in the static pressure in the middle ear may create a movement of fluid toward the intracranial cavity through the aqueductus cochleae. A flow in the opposite direction may occur when there is negative pressure in the middle ear. Kobrak used the reflex of the tensor tympani muscle as a hearing indicator in an attempt to study the effect of static movements of the labyrinthine fluid on hearing. The muscle was observed directly and by instrument. The threshold contraction for a given intensity was recorded. In this way the hearing test in rabbits was studied. The

hearing test in rabbits corresponded closely to the hearing test carried out in the clinic in man. This reflex is maintained by both labyrinths. For example, the reflex movement of the right tensor tympani muscle is maintained after destruction of the right labyrinth because impulses are obtained from the left labyrinth.

The free movement of the labyrinthine fluid intracranially accounts for the lack of energy when there is great increase of pressure in the middle ear. The passage between the labyrinth and the cranial cavity may be variable so that in some instances the pressure of the labyrinth may not be as easily transmitted to the cranial cavity as in others. Normal acoustic irritations of medium grade produce a tetanic contraction of both muscles of the middle ear. The contractions of the tensor tympani muscle are almost absolutely isometric. Effects on the tensor tympani muscle of a drop of a 1:1,000 solution of nicotine were studied. This produced very strong contractions of the muscle. The intracranial pressure contracts with the labyrinthine pressure, which in turn may be influenced from the outer or the middle ear. Therefore, from a diagnostic standpoint, lesions of the middle ear may be due to alterations in pressure in surrounding parts such as the middle ear or the intracranial cavity. Attempts at regulating the labyrinthine pressure may be made therapeutically.

HUNTER, Philadelphia.

THE EAR AND CRANIAL TRAUMA. ALBERT B. MURPHY, Arch. Otolaryng. **21**: 686 (June) 1935.

Murphy reports the results of the examination during the past ten years of 176 patients with cranial trauma who presented symptoms referable to the ear. Practically all the patients had been under observation and had been reexamined from time to time for at least three years, and some were still under observation after the ten year period. Murphy proposes the following classification for cases of cranial trauma: (1) cases of fracture involving the external canal only; (2) cases of fracture involving the middle or inner ear, and (3) cases of symptoms referable to the ear without apparent fracture. The first group is characterized by pain in the region of the temporomandibular joint and by sequestrums which heal without evidence of stricture of the canal.

In nineteen cases there was drainage of spinal fluid from the ear. Twelve patients died of the initial shock. Several roentgenograms of the skull must be taken in cases in which fracture is suspected. Roentgenograms rarely show the true extent of the fracture of the temporal bone. Extravasation of blood into the temporal muscle is of definite value in diagnosis, together with localizing symptoms, such as facial palsy, aphasia and nystagmus.

Eighteen of the patients with cranial trauma were totally deaf; none of them recovered. In considering vertigo following cranial trauma the author classifies the cases into two groups: compensation and noncompensation cases. He considers that dehydration and avoidance of the use of alcohol, exposure to heat and constipation during convalescence tend to lessen the after-symptoms.

HUNTER, Philadelphia.

A CASE OF SYNESTHESIA: VISUAL-PAIN AND VISUAL-AUDITION. GEORGE J. DUDYCHA and MARTHA M. DUDYCHA, J. Abnorm. & Social Psychol. **30**:57 (April-June) 1935.

Synesthesia is not common. The subject in this case was a college woman, aged 20, who one day remarked to her sister, "There goes another one of those lightnings!" On inquiry, the subject explained that she had certain visual perceptions of sounds, but it was not until she encountered the subject of synesthesia in an advanced psychology course that she came to appreciate the experiences and reported them in the psychology class of her college. She had had a rather extensive musical education—seven years' work on the violin and eight years' work on the piano—and came from a family of musicians. Two types of syn-

esthesia were experienced: visual pain and visual audition. The photisms in the case of pain were definite forms, each of which had a definite color, with two exceptions, the cramp and numbness. The photisms which accompanied audition were, on the other hand, definite forms which were never colored, merely having a certain brightness. Each photism was readily described or drawn by the observer, and at no time did she appear uncertain as to the form, color or brightness. The writers made a careful check of the subject's observations by questioning her repeatedly and by subjecting her to various experiments; she was absolutely consistent at all times.

The photisms accompanying eight types of pain appear at the place where the pain is located, each type of pain giving rise to a unique photism with characteristic form, color or brightness. For instance, a sharp, momentary pain is seen by the subject as a bright red needle-like figure. When the subject had a goiter removed, a double-pointed, spindle-like figure was seen, and it seemed to "move back and forth in a semicircle along the cut" or incision. Other pains, such as sharp prolonged pain, dull throbbing pain, shooting pain or headache, had characteristic shapes, colors and motility.

The photisms which accompanied auditory experiences had definite forms but no special color. They were usually seen in the indirect field of vision. A different picture acompanied various voices—the more rasping a voice the larger and sharper were the saw-teeth of the photism. The voice of the subject's roommate was described as being "light gray and metallic, like bright shiny tin." Noise was interpreted visually as a zig-zag band, about five thirty-seconds of an inch wide, with large saw-teeth. The sound of a frog snapper was visually interpreted as a "large, very black and shiny—inky" object the shape of a "doughnut." Instrumental music as analyzed by tuning forks produced a horizontal, perfectly smooth bar, with no apparent movement, which lasted as long as the tone lasted. Each tonal bar had its position according to its position on the musical staff. When several of the forks were struck in rapid succession, the subject could see all the tonal bars at once and always in their appropriate positions. A melody played on a pipe organ was visualized as a hollow tube twisted in step-like fashion. The oboe bassoon was seen as a "bag-like" photism, each bag representing a tone and being connected to the next bag by a light line. All of these photisms were an intimate part of the subject's experience and, for her were as vivid as actual perceptions.

WISE, Howard, R. I.

PUPILLOTONIA OR TONIC PUPILS. GEORGE B. HASSIN and JOHN THOMPSON, J. Nerv. & Ment. Dis. **80**: 430 (Oct.) 1934.

The "tonic" pupil is one which is sluggish in reacting both to light and to convergence; it is usually unilateral and commonly larger than its normal mate. It is not indicative of neurosyphilis. Three cases are presented.

CASE 1.—A man complained of visual disturbances and headache; vision was 1/200 in each eye but could be corrected to normal in the right, whereas the vision of the left eye could not be improved by glasses. The left pupil was irregular and larger than the right. The Wassermann reaction was negative. After the patient had been in a dark room for two hours the pupils, on exposure to diffuse daylight, became equal. On convergence the left pupil contracted very slowly, but it actually became smaller than the normal right pupil and then on relaxation of convergence dilated to its previous size.

CASE 2.—A man complained of pain over the eyes. The knee jerks were absent. The left pupil was smaller than the right, although in this case it was the left which was the tonic pupil. In the dark the pupils dilated, although the left did not reach the size of the normal right pupil. After prolonged exposure to the dark the patient was placed in daylight, and the dilated left pupil slowly returned to its previous constricted sizes. The Wassermann reaction of the spinal fluid was negative.

Case 3.—A woman had weakness, paresthesias, visual disturbances and headaches. Both pupils were irregular, but the right was the larger. In accommodation both pupils reacted well; but the right responded sluggishly and the left not at all to artificial light. After a prolonged sojourn in a dark room the woman was exposed to diffuse daylight; this procedure dilated both pupils to equal size. Serologic findings were negative in this case.

Hassin and Thompson are unable to explain the etiology or pathogenesis of the tonic state of the pupil. In their first case they consider that an injury to the brain might have been the responsible factor, since the patient had been a wrestler. The condition has also been reported in cases of diabetes, Thomsen's disease and myxedema.

Davidson, Newark, N. J.

Paralysis of Accommodation Without Pupillary Disturbances. L. Genet, Ann. d'ocul. **171**:607 (July) 1934.

Genet reports a case of complete paralysis of accommodation without pupillary disturbances in a child, aged 12 years. He believes the causative factor was infantile paralysis which occurred approximately at the age of 10. Paralysis without pupillary disturbances became complete within two years. There were no symptoms of diphtheria or botulism. Monosymptomatic epidemic encephalitis should be considered as a cause. In explaining the isolated paralysis of accommodation, Genet stresses the need for postulating the existence of a supranuclear center for accommodation.

Berens, New York.

The Rôle of Vascular Spasm in Ocular Pathologic Processes. Bailliart, Ann. d'ocul. **171**:615 (July) 1934.

Spasm of the ocular vessels may produce transitory blindness. The small foci of degeneration in the capillaries of the retina that occur in cases of so-called hypertensive retinitis probably have their origin in vascular spasm. Three factors frequently cause spasm: arterial lesions, disturbances of tension and the presence of certain toxic substances in the blood, especially those which accompany uremia. Spasm may play a rôle in albuminuric and diabetic retinitis.

Berens, New York.

Physiology of Light and Accommodation Reflexes: Argyll Robertson's Sign. M. Rischard, Ann. d'ocul. **171**:755 (Sept.) 1934.

The light reflex is a true sensory reflex, while the accommodation reflex is a voluntary motor action. This explains the Argyll Robertson sign (the iris is inactive to light but reacts in accommodation). This sign frequently occurs in tabes. Tabes is characterized by degeneration of the posterior root fibers resulting in sensory disturbances. If the pupillary fibers which carry the sensory stimuli are degenerated, the ganglion cells do not react to light; the reflex arc is interrupted, and the pupil becomes fixed to light. The pupil still reacts in accommodation because it is a voluntary motor action. In tabes the voluntary nerves are not degenerated and consequently inhibit the sympathetic nerves according to the law of the parasympathetic system (explained in the original article). The pupil does not react to light because the pupillary bundle is degenerated. But when the pupil does not respond to stimuli, not only the sensory parasympathetic system, but also the sympathetic system is degenerated.

Berens, New York.

Cranial Fracture Involving the Orbit and Nasal Accessory Sinuses with Progressive Pneumocephalus and Paralysis of the Third and Fourth Cranial Nerves. P. Bonnet, Ann. d'ocul. **172**:160 (Feb.) 1935.

Bonnet reports a case of fracture of the frontoparietal region, with involvement of the apex of the orbit and the frontal and ethmoid sinuses and with paralysis

of the third and fourth cranial nerves. Roentgenographic examination showed at first a small air sac near the frontal sinus, which six days later became a large pneumocephalus extending from the frontal sinus to the region of the fracture. Four months after the removal of air by puncture, the paralysis of the third nerve disappeared, but that of the fourth nerve persisted.

BERENS, New York.

SYNDROME OF BLUE SCLERA. P. BONNET and P. WERTHEIMER, Ann. d'ocul. **172**:226 (March) 1935.

Bonnet and Wertheimer report the case of a patient affected with blue sclera, which is characterized by: (*a*) fragility of the bones, (*b*) the blue color of the scleras and (*c*) deafness, as reported by van der Hoeve. The family history of the patient confirmed the hereditary nature of the disease.

BERENS, New York.

ON CHANGES IN SIZE AND FORM OF VISUAL IMAGES IN CEREBRAL DISEASES (MICROPSIA, MACROPSIA, METAMORPHOPSIA, TELOPSIA). LUDO VAN BOGAERT, J. belge de neurol. et de psychiat. **34**:717 (Dec.) 1934.

Van Bogaert refers to two previously recorded cases of subcortical tumor in the parietotemporal region. One patient had lilliputian hallucinatory experiences. The second complained of marked reduction in the size of visual images during an epileptic absence. The author now reports two new instructive cases, throwing some light on the pathologic physiology of these unusual experiences.

The first case was that of a woman aged 27, with multiple sclerosis. The first symptom came on at the age of 23, in 1922, when the patient suddenly lost her vision and noted flashes of red light passing across the visual field. She vomited at the same time. During 1922 and 1923 there was a transitory homonymous hemianopia on the left side, at least on two occasions. Between June 1923 and January 1924 the patient had about a dozen attacks characterized by severe vertigo, with rotation of objects from right to left, followed by headaches and often by definite disturbances in color sense, lasting a few hours. Examination of the visual fields was carried out in March 1924 and showed a concentric narrowing of the visual fields which varied from one examination to the next. The abdominal reflexes were present. There were lively tendon reflexes, with bilateral ankle clonus; there was a tremor in the upper limbs suggesting the toxic tremor seen in cases of exophthalmic goiter; the gait was unsteady for a few hours after vertiginous seizures. During 1924 the patient had two severe attacks of vertigo preceded by peculiar auras. There were no convulsive movements during these attacks. During the first she suddenly noted that objects became very small; at the same time she became aware of an intense odor of menthol as well as of a severe sensation of constriction in the throat and a feeling of emptiness. In the second attack, following a rather violent epigastric sensation the odor of menthol appeared again, with a sensation of intense fatigue. The patient noted at the same time that her mother seemed foreshortened and wider than normal and that she herself appeared as thin as a wire. The micropsia and metamorphopsia disappeared as the attacks of vertigo became less marked.

During 1925 there were a number of convulsive attacks with incontinence of urine, biting of the tongue and complete amnesia. These attacks were followed by deformation of objects lasting a number of hours. During the postconvulsive period the patient seemed to smell menthol and fresh rubber everywhere. External objects seemed to be smaller and often appeared as if they were toppling over, making an acute angle with the floor. During such periods, if the patient tried to arise she experienced severe vertigo. During 1927 she had a number of severe attacks with hemianopia and prolonged loss of consciousness. Examination in May 1928 showed a typical picture of multiple sclerosis, with absence of abdominal reflexes and

bilateral atrophy of the optic nerve. In 1932 there developed severe vertigo after the patient had listened to music for thirteen or fourteen minutes, especially music of low pitch.

In this case the author emphasizes the existence of a characteristic clinical triad—vertigo, parosmia and distortion of the visual image.

The second case was that of a woman, with diabetes mellitus of long standing, with the sudden onset of left homonymous hemianopia, forced deviation of the head and eyes to the left, a tendency of the body to rotate toward the left and extreme restlessness. Immediately after these changes she noted that objects in the visual field appeared much smaller than normal. This was accompanied by definite spatial disorientation. Following this ictus there were periods of delirious behavior. Between transitory hallucinatory episodes and accompanying attacks of forced conjugate deviation of the eyes to the left the patient reported distortions in the size and form of objects about her. At one time the furniture appeared wider or taller, and at other times smaller than normal, the distortion depending apparently on the spatial relation of these objects to her.

The succession of clinical changes in these cases suggests to the author a disturbance of the central vestibular mechanism, which Spiegel recently localized in the temporal lobe. The onset with vertigo and parosmia in the first case and deviation of eyes in the second indicate the probability of the spread of abnormal stimuli beginning in the temporal vestibular center to the visual sphere. The author adds that such changes are probably due to a disease of the angular gyrus, which normally protects the visual sphere from the spread of such vestibular stimuli. The angular gyrus acts as a barrier against such irradiations. When this function fails, visual experiences are perverted as a result of these central labyrinthine perturbations. The alleged function of the angular gyrus of aiding binocular vision during changes in position of the head and body by controlling conjugate ocular movements also probably plays a rôle in accounting for the appearance of these abnormal visual experiences.

SAVITSKY, New York.

A DIAGONALLY PLACED HOMONYMOUS HEMIANOPIC SCOTOMA DUE TO A VASCULAR LESION OF THE OCCIPITAL CORTEX. H. HOFF and O. PÖTZL, Ztschr. f. d. ges. Neurol. u. Psychiat. **152**:422 (March) 1935.

The patient, a man aged 59, had a right homonymous hemianopia in 1931, probably the result of a cerebral accident in June 1930. In May 1933, hemianopic hallucinations developed. Because of these hallucinatory experiences another study of the visual fields was made. A wedge-shaped homonymous defect, with the apex toward the center of the field, was found in the left upper quadrant. This defect was approximately in the diagonal meridian. There were signs referable to the pyramidal tract on the left side, difficulty with addition and subtraction was experienced. Approximately the same defect was found on reexamination one year later. The findings in this case are compared with the vertically placed homonymous scotomas reported by Holmes and the horizontally oriented defects recorded by Henschen. Occlusion of one of the smaller branches of the calcarine artery would make such defects as those noted in this case understandable.

SAVITSKY, New York.

Diagnostic Methods

THE ROENTGEN DIAGNOSTIC SIGNIFICANCE OF EROSION OF THE OPTIC CANALS IN THE STUDY OF INTRACRANIAL TUMORS. HENRY K. PANCOAST, Ann. Surg. **101**:246 (Jan.) 1935.

Three cases are cited in which erosion of the roof of one optic canal was a dependable sign in the localization of a tumor of the brain. Calcification was a further localizing sign in two of the cases. In one of the three cases the erosion was found on the side opposite to that indicated by uncertain clinical signs. A

ventriculographic study was necessary for final accurate localization. In a fourth case autopsy disclosed that the erosion occurred on the side opposite to that indicated by the clinical signs. The erosion was found to be due to the lateral displacement of the third ventricle.

GRANT, Philadelphia.

THE EFFICIENCY OF SERODIAGNOSTIC TESTS FOR SYPHILIS, EDITORIAL, J. A. M. A. **104**:2099 (June 8) 1935.

The report of the committee on the evaluation of serodiagnostic tests for syphilis in the United States appears in the same issue of *The Journal* as this editorial (page 2083). Facts pertaining to the serologic tests or modifications of such tests as have been used in the United States are given in detail. The committee has avoided entirely any comment on the method of any one serologist. The relative efficiency of the several tests is evident, however, if one cares to analyze the report. The study was comprehensive, and the results are comparable with those attained in the conferences held a number of years ago under the auspices of the League of Nations in Copenhagen and Montevideo.

In the actual performance of the tests, the participating serologists did not assemble in one place to examine specimens over a short period of time. They were given the advantage of performing these examinations in their own laboratories. The evaluation study in this country differed from that presented at former conferences in the selection of presumably nonsyphilitic donors. In Copenhagen and Montevideo, donors were selected from patients in a general hospital who were believed not to be infected with syphilis. In the evaluation study as conducted in this country, the nonsyphilitic donors were made up of a specially selected group in which there was reason to believe that the incidence of syphilis would be considerably lower than in patients in a general hospital.

Of much interest is the relative efficiency of flocculation tests as compared with complement-fixation tests for syphilis. Generally speaking, the former compared most favorably with the more complex serologic procedures both in specificity and in sensitivity. This was true especially when such tests were applied in the examination of blood serum. It was not true to the same extent, however, when the application was made to spinal fluid. The variation in specificity and in sensitivity from the highest to the lowest percentage was more definite in the examination of specimens of spinal fluid than in the study of specimens of blood and the percentage of positive reactions in specimens of spinal fluid from patients with neurosyphilis was low in the case of several of the flocculation tests. This indicates that the flocculation tests for spinal fluid should be given further study.

One of the most interesting conclusions of the committee is that a highly sensitive flocculation test alone might be employed as a routine procedure to exclude a diagnosis of syphilis. The evidence available indicates that when such a test is employed a negative reaction would practically eliminate the presence of syphilis as demonstrable by any other serologic method. However, because of the highly sensitive character of the flocculation test a positive reaction would not be indisputable evidence of syphilitic infection. A further recommendation therefore is made that when a positive result is reported with the routine highly sensitive flocculation test the serum should be reexamined by one or more specific complement-fixation or flocculation tests. The majority of serologic tests for syphilis performed in the laboratories of the country give negative results. The routine adoption of such a highly sensitive flocculation test in comparison with the routine performance of a combination of two or more serologic tests would be an important factor in reducing the cost of the serodiagnosis of syphilis. Such a method of serologic testing seems to be worth a trial and may offer a solution for the present high cost of this work in laboratories.

Information was not obtained with regard to the practical application of the individual serologic procedures as employed in laboratories throughout the country, nor is a specific statement made with regard to the cost of the several procedures

evaluated. Such factors are of the utmost importance, especially the practical application of serologic tests in private and public health laboratories.

The recommendation was made that the reporting of the qualitative results in the serodiagnosis of syphilis be simplified. A similar recommendation was made by the League of Nations after the conference at Copenhagen. The adoption of a different set of symbols to express the degree of positivity by every serologist who describes a new method or modification has been most confusing to the physician in the past. The committee is to be commended for its insistence on a simplified method of reporting in which all qualitative results are reported as positive, doubtful or negative.

EDITOR'S ABSTRACT.

SODIUM AMYTAL AS A MEANS OF OBTAINING CONTACT IN STUPOROUS AND UNCOMMUNICATIVE CASES. P. L. SMITH and D. K. SCHWARTZ, Psychiatric Quart. **8**:748 (Oct.) 1934.

Sodium amytal given intravenously was found to be of assistance in establishing contact with uncommunicative patients. The oral use of the drug was found ineffective for this purpose. Intravenously, the dose is 7½ grains (0.49 Gm.) dissolved in 5 cc. of double-distilled water. The rate of injection is not more than 1 cc. a minute. The full dose should be used. Patients become drowsy during the injection and then fall asleep for a short period (usually from five to thirty minutes). On awakening they usually answer questions and may give the interviewer much information about the development of the psychosis and the content of their thought not obtainable otherwise. After the single intravenous injection the authors maintained some narcosis with oral administration of sodium amytal. The contact during this period was not usually as good as when the patients were under the influence of intravenous administration. For oral use the drug is dissolved in water, at a rate of 1 grain (0.065 Gm.) to 20 cc. of water. The initial oral dose is 3 grains (0.195 Gm.); the maintained dosage is 6 grains (0.4 Gm.) twice a day, supplemented by a 3 grain dose during the day.

DAVIDSON, Newark, N. J.

THE VALUE OF TRYPTOPHAN IN THE BLOOD SERUM OF PATIENTS WITH MENTAL DISEASE. ANTONIO CAMPANA, Riv. di pat. nerv. **45**:69 (Jan.-Feb.) 1935.

Campana studied the tryptophan content of the blood serum in persons with various mental conditions in order to test indirectly the protein quotient and more particularly the globulin-albumin relationship of the protein molecule. In cases of so-called amentia (acute confusional hallucinatory conditions) there is a definite, though not marked increase in the amount of tryptophan in the blood serum. This is absent in cases of dementia praecox and manic-depressive psychosis. The increase in tryptophan is also appreciable and more frequent in cases of dementia paralytica, in which Campana thinks there is a special lability of the protein molecule of the blood serum. The increase of tryptophan is not proportionate to the gravity of the mental condition or to the severity of the confusional symptoms.

FERRARO, New York.

TESTS OF HEPATIC FUNCTION IN VARIOUS MENTAL DISEASES. G. MARKOVITS, Monatschr. f. Psychiat. u. Neurol. **88**:248 (April) 1934.

The functional activity of the liver was investigated in 100 cases of mental disorder. The Rosenbach-Gmelin test and Rosin's test for bile pigments in the urine and the elimination of phenol-tetra-iodophthalein from the blood serum were the procedures used. In some instances Rosenthal's test was also employed. Abnormal results were obtained in 13 of 20 cases of chronic alcoholism. The severest changes occurred in patients who were suffering from psychoses. Pronounced disturbances of hepatic function were observed in 6 persons who were

addicted to the use of morphine. Delayed elimination of the dye was noted in 5 patients with chronic encephalitis. There were 40 cases of schizophrenia, of which 22 were classified as instances of the catatonic type. Only one patient with this type failed to show delayed elimination of the dye. Abnormal results were obtained in 6 cases of schizophrenia of other types. There were 13 cases of melancholia, in 12 of which outspoken retention of the dye occurred. Three patients with depressions of undetermined origin and 1 patient in a manic state presented disturbances in the function of the liver. Eleven patients with different types of nervous disorder were used as controls. The results were normal in these patients. It is evident that abnormalities of hepatic function are common in association with certain types of mental disease, but Markovits believes that it would be premature to draw conclusions concerning the significance of the alterations.

ROTHSCHILD, Foxborough, Mass.

Society Transactions

NEW YORK NEUROLOGICAL SOCIETY

Regular Meeting, Oct. 1, 1935

ISRAEL WECHSLER, M.D., *President, in the Chair*

CONGENITAL STENOSIS AND ATRESIA OF THE AQUEDUCT OF SYLVIUS. DR. HARRY N. ROBACK (by invitation) and DR. MARK GERSTLE JR. (by invitation).

This paper will be published in full in a later issue of the ARCHIVES.

MASSIVE SYMMETRICAL BILATERAL NECROTIZING ENCEPHALOPATHY DUE TO ANGIITIS (PERIARTERITIS NODOSA?). DR. JOSEPH H. GLOBUS and (by invitation) DR. NORMAN A. LEVY.

The patient, a white boy aged 10 years, was well until five months before admission to the hospital. He had had pertussis at the age of 8 months, measles at 11 months and varicella at 2 years, and tonsillectomy had been performed at 3 years. At the age of 7 he suffered an injury to the head; although unconscious for fifteen minutes he was able to walk home. A roentgenogram made soon afterward revealed no evidence of a fracture of the skull. Two months later, however, the boy complained of supra-orbital headaches and dimness of vision in the left eye. The faulty vision was corrected by glasses, but the mild headaches continued intermittently for the next three years. At the age of 9 he had an acute febrile illness, lasting eight days, which was characterized by severe sore throat, high fever and a spotty rash on the arms and legs. There was no subsequent desquamation. After this illness he suffered from frequent colds and "sinus trouble" and had frequent mild frontal headaches.

The terminal illness was of sudden onset, five months before admission, with one generalized convulsive seizure and loss of consciousness, which lasted for five minutes. Four months before admission the parents noticed that the child's memory was not as good as formerly and that he was somewhat less active. This impairment of memory increased and until the onset of the more acute symptoms just prior to admission formed the outstanding feature of the illness. Two weeks before admission he complained of frontal headaches and vomited several times. One week prior to admission he had an attack of coma which lasted one hour and was followed by semistupor for twenty-four hours and somnolence. During the following week he was admitted to the Mount Sinai Hospital on Oct. 2, 1934.

Examination.—The patient presented a habitus of the so-called Fröhlich type, with a feminine distribution of fat and undescended testes. The temperature and pulse rate were normal. The blood pressure was 118 systolic and 80 diastolic. The heart and lungs were normal. Though somnolent, the patient was cooperative. He showed considerable intellectual impairment. There was a marked defect in memory for both recent and remote events. Considerable restlessness and frequent scattered patternless movements of the hands and feet were noted. The right pupil was irregular and dilated and was larger than the left; it was almost fixed to light and in accommodation. The left pupil was regular, reacted sluggishly to light and was fixed in accommodation. The consensual reflex was present on the right and absent on the left. Vision in the right eye was 20/70, and in the left eye, 20/30. There was no papilledema. The extra-ocular movements were normal, and there was no nystagmus. There was slight weakness of the lower

part of the left side of the face. The deep reflexes were active and equal, and there was a questionable bilateral Babinski sign. The abdominal reflexes were present, but diminished.

Course.—The spinal fluid was xanthochromic and contained 90 cells, all mononuclears. The pressure fluctuated between 140 and 360, but there was no evidence of block. The sugar content was 50 mg. per hundred cubic centimeters; the chloride content, 725 mg., and the total amount of protein, 500 mg. The white cell count was 10,400, 40 per cent of the cells being polymorphonuclears and 46 per cent lymphocytes. The red cells numbered 5,000,000, and the hemoglobin content was 92 per cent. The urine was essentially normal. The basal metabolic rate was —21 per cent. The Wassermann reaction was negative. The patient complained frequently of headache, and there was persistent bradycardia. A roentgenogram of the skull showed a small sella turcica and no evidence of increased intracranial pressure. On the seventh day after admission right homonymous hemianopia was noted and subsequently there were mimetic facial weakness on the right side and a tendency to a Babinski sign on the left. On October 11 encephalography was attempted, but it was stopped after the withdrawal of 20 cc. of xanthochromic fluid because the boy complained of difficulty in breathing. After this the memory defect increased, but there was no aphasia. On October 15 ventriculography was performed through the right occipital pole. Only 10 cc. of xanthochromic fluid escaped, and 50 cc. of air was injected. The roentgenogram showed a slightly dilated right ventricle and no air in the left ventricle. It was thought that the patient had an expanding intracranial lesion, most probably a suprasellar neoplasm—possibly a tumor of Rathke's pouch.

Ventriculography was again attempted on October 18, through the left occipital pole. The operator was unable to find the ventricle, but a small piece of tissue was aspirated. On October 22 craniotomy in the left parieto-occipital region was performed. The occipital convolutions appeared flattened, but no lesion was visible. The cortex was incised, and at a depth of 5 cm. a hard mass was encountered. This mass appeared to extend so far anteriorly that only partial removal by curettage was considered advisable. Microscopic examination of the tissue removed at operation showed disintegrated brain tissue in which there was perivascular infiltration with mononuclear cells and moderate gliosis. No tumor tissue was seen. These changes were interpreted as indicative of a reactive process in the vicinity of a massive lesion, probably a neoplasm. After the operation right hemiplegia, aphasia and complete amaurosis developed. The general condition became progressively worse; atrophy of the optic nerve slowly developed, and during the subsequent weeks the boy led a vegetative existence. There was low grade intermittent fever, but the operative wound showed no signs of infection. About a month after operation involuntary hyperkinetic movements appeared on the left side, and bilateral papilledema was noted superimposed on the atrophy of the optic nerve. The hyperkinetic movements soon involved both sides and became so pronounced that the patient had almost continuous convulsive seizures. He died in status epilepticus on November 22, one month after operation and seven weeks after admission. The terminal symptoms were believed to be due to involvement of the basal ganglia by the neoplasm.

Necropsy.—Gross Anatomy: A postmortem study was made only of the brain. It appeared slightly larger than normal, and the convolutions were everywhere flattened. At the operative site the left temporoparieto-occipital region bulged markedly; it consisted of disorganized, softened tissue. When the brain was sectioned horizontally at various levels there were noted large areas of altered tissue, grayish pink and softer than normal, with many red and discolored spots varying in size. The areas of necrosis had a strikingly symmetrical bilateral distribution and extended from the structures about the rostral portion of the third ventricle to involve the corpora striata, the thalami, the posterior limb of the internal capsule, the occipital lobe in the regions adjacent to the posterior horn and the deep parts of the temporal lobes. The ventricular system was markedly distorted.

The third ventricle was practically obliterated and displaced to the left. The left anterior horn was narrowed, and the right was dilated; both were displaced to the left. Both posterior horns were narrowed, the right being almost completely occluded. The ependymal lining of the ventricles was yellowish and had a granular appearance. Sections through various levels of the brain stem showed a few small discolored spots and small red streaks, particularly in the lateral portion of the left peduncle and in the left dorsolateral part of the medulla, between the left olivary and the restiform body.

Microscopic Anatomy: Sections from various regions of the brain and brain stem revealed widely disseminated inflammatory and necrotizing lesions. The most striking changes were in the grossly diseased areas in the basal ganglia and the regions in the vicinity of the posterior and inferior horns. Sections from different parts of this massive lesion stained with hematoxylin and eosin showed extensive and profound necrosis of a peculiar coagulating type affecting all elements of the brain tissue, so that few recognizable structures remained except numerous diseased blood vessels. The most profound necrosis was in the immediate vicinity of the involved blood vessels. The vessels, both large and small, showed degenerative and inflammatory changes of varying degree. This was well demonstrated with Weigert's elastic tissue stain and the Van Gieson stain. Many vessels, especially the smallest ones, were completely necrotic and converted into structureless, homogeneously staining circles. Others, not so completely degenerated, showed swelling and edema of the intima, varying degrees of swelling and necrosis of their walls and infiltration of all the coats with mononuclear and polymorphonuclear cells. In some vessels numerous red cells were observed within the layers of the walls; the condition simulated that seen in dissecting aneurysms. In some of the necrotic vessels the internal elastic membrane was partially preserved, while in others it had completely disappeared. Many vessels, particularly the smaller ones, were completely occluded by fibrin, and deposits of fibrin were seen in the areas about thrombosed and obliterated vessels. Extravasations of blood into the surrounding tissue were found about many of the vessels. These vascular changes became less severe as the periphery of the necrotic areas was approached, where the inflammatory involvement was more prominent.

Sections from regions of the brain remote from the massive lesion showed widely disseminated inflammatory and degenerative disease. Small foci of perivascular round cell infiltration were found in the occipital and temporal lobes and to a less extent in the frontal lobes. Similarly, a moderate glial reaction was noted in the same regions.

DISCUSSION

Dr. H. A. Riley: Was any detailed examination made of the blood vessels of other organs removed at necropsy?

Dr. Joseph H. Globus: No.

Dr. H. A. Riley: Was there nothing abnormal detected clinically to indicate any irregularity in the walls of the palpable blood vessels and was nothing seen in the blood vessels of the fundi?

Dr. Joseph H. Globus: No.

Dr. Charles Davison: From the slides presented I possibly would have made a diagnosis of encephalitis. I have seen a number of inflammatory conditions of the nervous system, and occasionally one sees blood vessels involved in intimal and adventitial infiltrations. Of the three coats of the vessels, the media is the most resistant to disease. This probably is the explanation for the absence of involvement of the media in this case. Did Dr. Globus find other inflammatory foci besides those around the blood vessels.

Dr. Joseph H. Globus: I disagree with the suggestion of Dr. Davison that the case is one of encephalitis. I believe that the vascular lesion in encephalitis is different from that demonstrated here. In encephalitic lesions one encounters

adventitial infiltration; in this case there was a considerable necrosis. I have yet to observe a case of epidemic encephalitis or polioencephalitis in which there was necrosis of this type.

As to whether I have seen foci of inflammation besides those around the blood vessels, I would say that inflammatory lesions of the brain or elsewhere usually occur in the vicinity of the blood vessels. That is the way in which the agent which causes the inflammation reaches the area in which the inflammatory processes take place; therefore, inflammatory lesions occur commonly around blood vessels. In the early studies of encephalitis focal infiltration was often spoken of to indicate that there were areas of infiltration, i. e., accumulations of lymphocytes and other inflammatory cells in which no visible blood vessel could be found. The reason for that is not that there is no blood vessel in the area in which the inflammation was found, but that the sections are cut tangentially to the blood vessels. Were they cut serially, a blood vessel would ultimately be reached. There is no inflammatory lesion in the brain independent of blood vessels. Every inflammatory disease is centered about a blood vessel.

INFLUENCE OF POSTURE ON CONVULSIONS. DR. IRVING BIEBER (by invitation) and DR. I. S. WECHSLER.

That epileptic seizures frequently occur at night is an observation for which a number of explanations have been offered. We suggest that posture also stands in etiologic relation to the onset of an attack. This is based on the observation of several patients whose convulsive seizures occurred mainly while they were in the recumbent position, either by day or by night. The following cases illustrate the point.

Case 1 is that of a woman, aged 21, who had had tonic and clonic seizures of the right upper extremity and conjugate movements of the head and eyes to the right for six years. The attacks came on at night within half an hour after the patient lay down; most of them occurred while she was lying on the left side. Exploratory craniotomy revealed a discrete arachnoid cyst, 1 by 2 cm., anterior to a point on the motor cortex from which typical area 4 responses of the hand were elicited. Electrical stimulation of the region about 2 cm. anterior to the cyst elicited a violent convulsive seizure.

Case 2 is that of a woman, aged 34, who had right hemiplegia and aphasia after a subarachnoid hemorrhage; exploratory craniotomy showed no lesion on the left side. She had forced grasping in the right hand. She gradually recovered from both the hemiplegia and the aphasia but began to have convulsions while asleep and when lying on the left side.

Case 3 is that of a girl, aged 11, who had cerebral birth palsy involving the right side and had suffered from convulsions since the age of 4. The seizures came early in the morning while she was lying in bed. She also had a turning of the head and eyes to the left.

Case 4 is that of a woman, aged 49, who had had convulsions for seven years. The attacks occurred mainly at night, but they also occurred during the day when she was in a recumbent position.

Before evaluating our observations it may be well to refer to the body-righting reflexes on the body, which Magnus described (Koerperstellung, Julius Springer, Berlin, 1924, p. 243). These reflexes depend on postural changes. Fulton and Bieber (The Relation of Forced Grasping and Groping to the Righting Reflexes [in preparation]; Preliminary communication in *Am. J. Physiol.* **105**:8, 1933) observed similar patterns in monkeys deprived of the motor and premotor areas bilaterally which demonstrated the importance of the premotor area in modifying the influence of the body righting reflexes on the body. Fulton and Bieber observed that forced grasping bears a definite relationship to the postural pattern, being present only in the upperlying flexed limb. Kennard, Viets and Fulton (The Syndrome of the Premotor Cortex in Man: Impairment of Skilled Movements,

Forced Grasping, Spasticity, and Vasomotor Disturbances, *Brain* **57**:69, 1934) observed this phenomenon in a patient with a tumor of the premotor area. Wechsler, Bieber and Balser (Postural Reflexes in Patients with Lesions of the Frontal Lobe, to be published in the ARCHIVES) observed 4 patients with forced grasping in whom there was evidence that the body-righting reflexes on the body bore a definite relationship to the forced grasping.

Reviewed in the light of these investigations, our material presents a group of facts which, when correlated, allow some interesting speculations. In all 4 cases the attacks occurred mainly when the patient was in the reclining position. In case 1 the patient believed that the convulsions began more frequently when she was in the left lateral position (affected limb uppermost), and in case 3 during the course of the seizure the patient turned to her left side, thus again placing the affected extremity uppermost. In case 1 the episodes took place soon after the patient assumed the recumbent posture, whether she was asleep or not. In cases 1 and 2 there was evidence of disease of the premotor area. In the first case exploratory craniotomy revealed involvement of this area; in the second case its presence may be inferred because of the forced grasping. In case 2 the grasping varied with the position of the patient, demonstrating the influence of the righting reflexes. In case 3 the adversive movements of the head, eyes and trunk took place to the side of the cerebral lesion, in a direction opposite to that which usually occurs.

These observations suggest the following deductions: When a patient assumes the reclining posture, a large portion of the surface of the body becomes stimulated by its contact with the supporting surface. This serves as an adequate stimulus for the assumption of postural patterns conditioned by the body-righting reflexes on the body. Ordinarily, in normal persons these patterns can be inhibited by the premotor areas, as demonstrated by the experiments of Fulton and his co-workers. However, when the premotor area is diseased, a functionally insufficient zone is called into activity. After a varying period, during which this functionally insufficient area can inhibit these reflex patterns in the recumbent patient, the zone becomes "decompensated," undergoing physiologic disintegration. The tonic spasm thus appears as the phasic representation of the described pattern. The increased intensity of the forced grasping after the seizure in case 2 suggests such a disorganization. Moreover, if it is assumed that the motor and premotor areas inhibit the type of posture that usually makes its appearance in cases of hemiplegia when there is anatomic evidence of destruction of these areas, then it may be assumed that when similar postures appear in cases of epilepsy these areas are functionally disorganized. If a clonic convulsion supervenes, it is possible that an epileptogenic focus in or about the decompensated area is set off or that an adjacent cortical or subcortical area is stimulated to abnormal activity. The fact that the epileptogenic focus is in relation to the physiologic activity of its surrounding area is illustrated by a case brought to our attention by Dr. Eugene Greene. The patient was able to inhibit the progress of the convulsion by consciously forcing his head and eyes to the left. It is a long established fact that when one zone which stands in reciprocal relation to another is stimulated its homolog is inhibited. Thus, by volitionally stimulating the homologous area in the opposite hemisphere, this patient reciprocally inhibited the diseased one, causing cessation of "firing" from the zone and its epileptogenic focus. The fact that there may be abnormal activity of an area in anatomic proximity to the "decompensated" zone finds illustration in our first three cases. In cases 1 and 2 the adversive movements away from the cerebral lesion are expressions of stimulation of the adjacent adversive area; in case 3 the adversive movements toward the cerebral lesion are expressions of inhibition of this adversive area. It is interesting to note that during the seizures (in cases 1 and 2) of the two adjacent cortical areas there was stimulation of one and inhibition of the other.

Our purpose in presenting this group of cases is to establish a relationship between posture and the onset of convulsions. We recognize, of course, the importance of other factors, such as physical and chemical changes and alterations

in intracranial pressure occurring during sleep, which may influence the onset of paroxysms. We offer our impressions as a speculation: that the righting reflexes set in motion by the recumbent position are a factor in determining the onset of convulsions at night.

DISCUSSION

DR. E. D. FRIEDMAN: A number of years ago, in a case in which there was a doubtful Babinski sign on one side, Walshe found that by turning the patient's head one could elicit the Babinski sign better on the side of the occiput. During deep sleep, too, it is possible to elicit dorsal extension of the great toe both in older children and in adults; there must, therefore, be a certain recession during sleep to primitive patterns which then find expression. The clinical phenomenon which Dr. Bieber and Dr. Wechsler have described probably is dependent on a similar mechanism. The thought occurred to me that perhaps there might be another factor in the cases in which these convulsive episodes occur during sleep. This does not apply to those in which the convulsions are elicited by a change in posture when the patient is awake. During sleep the vagus nerve shows heightened activity. The vagus is the nerve of anabolism. There is no need for excessive mobilization of sugar during sleep. The blood sugar level therefore falls, especially toward morning.

A number of years ago I reported before this section several cases of epilepsy with coincident vagotonic symptoms (ARCH. NEUROL. & PSYCHIAT. **24**:1904 [Nov.] 1930). Concomitant with the epileptic seizure there was bradycardia (the pulse rate was at times as low as 48 per minute); there were, in addition, spastic constipation, vagus arrhythmia and other evidences of vagotonia. It occurs to me, therefore, that in cases in which the epileptic episodes occur during sleep, some such mechanism may come into play. May I recall the work of Frisch on the vegetative nervous system of the epileptic person, in which he presented evidence of its instability? I should offer as an alternative suggestion for the causation of convulsions in those cases the diminution of the blood sugar and the heightened vagotonus which accompanies sleep.

DR. H. A. RILEY: While these phenomena seem to be associated, there is still no definite proof of connection between the occurrence of the seizures and any particular posture assumed during sleep or after recumbency. The posture during sleep may consist of many different positions. Is there a direct connection between posture and some abnormal stimuli set in motion by the assumption of that position, and is there breaking down of natural barriers to the convulsive seizure which exist in the brain? I do not think that Dr. Wechsler and Dr. Bieber have shown definitely that either situation exists.

The only case which I can think of in my own experience which illustrated the effect of posture on seizures was that of a patient whom I have seen occasionally during the past two or three years who could almost regularly bring on an attack of petit mal, or an attack which progressed to a more serious convulsion, by crossing the left leg over the right and allowing it to remain so for a period of time, at the same time turning the head to the right or stretching out the left arm. If he is not careful and sits with the left leg crossed over the right, and makes any of these additional movements, he is likely to occasion either an attack of petit mal or a grand mal seizure.

DR. PAUL SCHILDER: I have had occasion to observe one case in which the petit mal and jacksonian attacks were affected by a change in the posture of the head. In this case the righting reflex was increased very much. It is probable that the epileptic fit may be dependent on the total situation in the central nervous system. Possibly posture has a provocative influence at certain times. On another occasion it may be stimulation of the sole, as in one of my cases in which that maneuver provoked the jacksonian attack. Since there are no isolated phenomena in the central nervous system, it may be that factors of posture and any other stimuli may influence the coming and going of the epileptic attacks.

One more random remark, which has only a slight connection with this problem: Dr. Hoff made a study of what happens when one forces a person to sleep in a posture different from the usual sleeping posture. He found that vestibular dreams occur. Vestibular dreams are well known from studies made in patients with severe disease of the middle ear. The vestibular apparatus, which is so closely related to posture, can be stimulated by a sleeping posture which is different from the usual one. Posture influences everything that is going on in the central nervous system.

DR. A. M. RABINER: The question of posture in its relation to the production of convulsive seizures brings up another problem. Some years ago Dr. Foster Kennedy said that all persons are subject to fits when they lie in bed. In that transitory period between wakefulness and sleep there occurs frequently a sudden jerk of the entire body. He said that this constituted a fit, and I agree with him. It is a sudden objection to losing consciousness. There is an emotional factor in this, and all know that emotional stress frequently brings on convulsive seizures.

The relationship of the righting reflex in these cases I think is open to further analysis. These animals that Dr. Bieber discussed, which lie on one side and grasp with the uppermost extremity, do so not so much because of a righting reflex, but owing to a sense of insecurity; they grasp because of apprehension and try to find themselves in space. That is why the animal grasps with the uppermost limb and not with the limb on a solid foundation.

The other question mentioned by Dr. Friedman and Dr. Riley is of extreme importance. One of my patients recently, after a day's work, would come home and just before dinner would sit in a chair, doze off and have a convulsive seizure. One could say that the posture brought on the fit, but study revealed definite hypoglycemia, and on adequate treatment of this metabolic disorder the convulsions ceased.

DR. WALTER M. KRAUS: The paper of Dr. Bieber and Dr. Wechsler on the influence of posture on convulsions seems to me to emphasize a new clinical point of view. I think that Dr. Friedman's remarks about metabolic changes during sleep deserve much more attention. First, there are marked changes in the circulation and the pulse rate during sleep. Second, an observation in terms of the depth of sleep would be interesting, because it has been shown that the depth of sleep, from the moment of going to sleep, increases in the first two hours and then diminishes first rapidly and then gradually until awakening occurs. Consequently, if the fits have anything to do with metabolic changes that occur during sleep, the time of their occurrence would be worthy of observation. If the fits have anything to do with a fall in blood pressure, it would be interesting to see whether they could be reproduced by artificially lowering the blood pressure by such a drug as amyl nitrite.

I think that the thesis of Dr. Bieber and Dr. Wechsler is correct but that other factors, some of which have already been emphasized by Dr. Friedman, are to be considered as having much more influence than one might conclude from the paper itself.

DR. I. S. WECHSLER: Of course, Dr. Bieber and I do not mean to infer that posture alone is responsible for convulsions at night. The observation that convulsions do occur at night is an old one, and more than forty years ago Gowers discussed this question in great detail. In addition to the factor mentioned by Dr. Friedman, namely, sugar metabolism, there are several others which may account for the occurrence of convulsions at night. There is an increase in intracranial pressure during sleep, which accounts for sudden hemorrhages that occur at night and probably for some convulsions. There is a definite nocturnal change in the hydrogen ion concentration, in the direction of alkalinity, and increased alkalosis will produce convulsions. There is increase of the cholesterol content at night, and that, too, may precipitate seizures. So may the change in hydrodynamics.

Granting these factors, the question remains why do certain patients who are about to fall asleep or have just fallen asleep have convulsions? There are those

who invariably have convulsions within a short period after going to bed. There are also patients who have convulsions either immediately before awakening or soon after arising. It is obvious that the factors of a reduction in the blood sugar content, an increase in intracranial pressure, an increase in alkalosis, etc., must take time to develop during sleep, and it is a fact that most convulsions caused by those factors occur in the early morning hours, between 3 and 4 o'clock. We do not refer to these cases but to others in which the question of posture comes into play. Whatever else a convulsion may be, it is a violent disturbance of posture, and it is not illogical to assume that it can be influenced either favorably or unfavorably by changes in body posture. In case 3 Dr. Bieber did not mention that the patient could at times abort the convulsions by turning her hand at the beginning of the seizure. We used to disbelieve people who said that they could abort convulsions by turning the hand. The patient's own observation may be correct. It may possibly be explained on the basis of postural changes.

Our observations may have some localizing value in the diagnosis of lesions of the brain. On occasion I have made a diagnosis of tumor of the frontal lobe when the evidence in the case did not warrant such localization, the possibility being suggested by the postural change alone. In 1 or 2 cases the inference I made was right. It seems to me that the point we are making as to the influence of posture on convulsions operates in some cases of lesions of the frontal lobe or of the premotor and motor areas. It does not apply in all cases.

Dr. Irving Bieber: In reply to Dr. Rabiner's remarks on the grasping of the upperlying extremities, I may point out that if in animals pressure is applied to an extensive area on the upperlying body surface, the grasping disappears.

A Neurologic and Psychopathologic Study of Juvenile Adiposogenital Dystrophy. Dr. Bela Mittelmann.

The paper is based on the study of 16 cases of the nonneoplastic type of the Fröhlich syndrome. The ages of the patients varied from 4 to 13 years at the beginning of the observation and treatment. The diagnosis was based on the presence of obesity, especially around the pelvis and shoulders, and of disturbances in the genital development, such as smallness of the penis and undescended testes. All the patients studied were boys. In addition, the patients showed changes in the skeletal development: genu valgum and greater distance from the symphysis pubis to the soles than from the symphysis pubis to the vertex (eunuchoid measurements). The basal metabolic rate was lowered, ranging from —29 to —6.

The neurologic findings were muscular hypotonia, differences in associated movements of the right and left arms, intention tremor, which included tremor of the head and of phonation, marked involuntary movements of the outstretched arms, a tendency to deviate from the adult norm in postural reflexes, paradoxic neck-arm reactions, absence of maintained muscle tone and a peculiar clumsiness and difficulty in executing skilled movements. Some patients showed one or more of the neurologic symptoms, and some showed none. I examined a control group of 20 normal children for postural reflexes and found some of the mentioned deviations from the adult norm, but in a much smaller percentage than in the patients with Fröhlich's syndrome.

The psychopathologic findings were traceable partly to physiologic factors. The poverty of drive, related to the low basal metabolic rate, was one determinant of the passive, submissive, overdependent behavior of some of the patients. A strong oral trend, manifested by overeating, nail-biting, a tendency to chew pencils, etc., was probably also physiologic in origin. A different type of pathologic psychic manifestation was represented by reactions of the total personality to circumscribed deficiencies of the body and its functions. These deficiencies were obesity, smallness of the genitals and disturbances of motility, which resulted in an inability to compete efficiently with playmates and in being ridiculed by them. The patients' reaction to these narcissistic injuries was either one of withdrawal, i. e., overdependence on the mother, a passive, submissive feminine adaptation, or

one of hostility, i. e., an increase in sadism, disobedience, assaultiveness, stubbornness and tantrums. In either case a feeling of inadequacy or depression may be present and also anxiety attacks. Both types of reaction represent attempts at compensation for the narcissistic insults, the first by increased protection and by passive, feminine substitutive gratification and the second by a renewed effort to master the environment and by an attempt to bolster up the self-esteem and also by substitutive sadistic gratification. Both types of reaction my be present in the same patient; the physiologic factors mingle with the psychic reactions. I consider the hyperkinetic type of behavior shown by some patients to be anatomicophysiologically determined by lack of adequate check of motor impulses.

The therapy consisted of the administration of thyroid orally and an extract of the urine of pregnant women intramuscularly, up to 400 rat units per day. The prognosis of the endocrine disorder is good. The genitals may develop spontaneously, but they always respond to organotherapy promptly. In addition, dieting may be necessary to reduce the obesity. The neurologic symptoms persisted even after the dysendocrinism was corrected (longest observation, four years). The hyperkinetic behavior showed no response to either organotherapy or psychotherapy.

DISCUSSION

DR. I. S. WECHSLER: The first case of adiposogenital dystrophy was described by Babinski (Tumeur du corps pituitaire sans acromégalie et avec arrêt de developpement des organes genitaux, *Rev. neurol.* **9:** 531, 1900) a year before Fröhlich described it. Babinski was chagrined all his life that the fact was ignored. Fröhlich (Ein Fall von Tumor der Hypophyses ohne Acromegalie, *Wien. klin. Rundschau* **15:** 883, 1901) must have actually copied verbatim the title of the paper written by Babinski.

DR. A. A. BRILL: This paper gives an excellent description of the interrelationship of the physical and the mental attributes in cases of adiposogenital dystrophy. I am naturally interested only in the mental reactions in such cases. Most of the patients I have seen have been adults; they all gave histories of having been fat children, who suffered for their obesity. Society seems to carry some resentment against persons of this type, probably because they show by their bodily conformation that they enjoy more than their share of the good things of life; they look so prosperous. In early life they were teased by other children, and as a result they sustained some traumatic reactions, particularly because of insults referring to the genitalia. In the beginning of the psychoanalytic movement it was customary to speak of the "small penis complex," which was frequently found in this type of person. Such patients constantly worry about the smallness of the penis, and as a result acquire a definite reaction to life. All of them fit into Dr. Mittelmann's classification. As adults some of them are passive, submissive and accept their fate; they act as if they had been castrated and feel inferior. Others overcompensate for the inferiority by pugnacity and overactivity in various spheres; some who have talent play principal rôles in life. Thus, Napoleon I had a very small penis. The smallness of his genitals is stressed in notes on his autopsy. Most patients who are aware of the smallness of the penis seek to remedy the defect. A number of them have normal sex organs but are neurotic about them. Distorted fantasies and compulsive symptoms center on the penis in some cases.

One can often recognize such persons even outside the consulting room. Such a man once sat next to me at table on a trans-Atlantic steamer. He was a successful business man of the pugnacious type, who was ready to dispute anything said by others. He seemed to be interested in my specialty, and once while promenading the deck with me said; "Is it not funny that as I walk with you I feel as if a long sword were dragging after me? To be sure, I am just coming back from Germany and I have seen many soldiers, but the same thing happened to me on many occasions. Usually, as I walk, I forget myself and feel as if a long sword were dragging after me." I said nothing to him at the time, but on a later occasion, when he mildly challenged my specialty and wished to know

what psychoanalysis told me about him after a week's observation, I remarked that he seemed perfectly well except for his worrying over the size of his penis. He was most surprised at my statement and admitted the truth of it but could not understand how I knew of his intimate worry. I explained that his characteristic behavior and the obsessive fantasy readily demonstrated his small penis complex. His fantasy was nothing but a wishful compensation for the supposed small penis. Physically, too, he corresponded to the type described by Dr. Mittelmann.

Some time ago a young man consulted me because he was mentally inferior. His only reason for this obsessive thought was that he wore a hat which was size 6 7/8. This, he thought, showed that he was inferior. He added that his average in college and in the university was 85 and that no one considered him in any way deficient; still, he was obsessed by the idea that he was inferior. It required little study to discover that his obsession of mental inferiority because of the size of his hat was a displacement from below—a repressed worry over the smallness of his penis. He admitted that inquiry in many hat stores showed that this size represented the normal size and that competent medical authorities told him that his head was normal. He was much impressed by my explanation and readily admitted that the obsession of the smallness of his head appeared a few months after he tried hard not to think of the smallness of his penis. This overcompensation is also observed in psychotic patients with dementia praecox of the paranoid type in whom the reaction is delusionally elaborated. I recall such a patient in the United States Veterans Hospital No. 81, who stated that his penis extended from the hospital to the Flatiron Building. Inquiry readily disclosed that he, too, originally suffered from a small penis complex. I do not know whether he ever showed the adiposis described by Dr. Mittelmann.

DR. PAUL SCHILDER: I think that it is important to keep in mind that in childhood great changes in motility take place. A series of interesting studies on this subject have been made by Homburger. The motility of human beings is not static. There are periods of life in which changes develop at a greater speed and periods in which changes come about more gradually. Taking adult behavior as the norm, one may say that aberrations in motility, especially concerning posture, are common after the sixth year and increase in the preadolescent period. No part of motility is excluded from this process of development, but the postural reflexes undergo particularly important changes.

The postural reactions that Dr. Hoff and I studied are reliable and constant findings in the adult. We had difficulties in establishing a norm for children. No thorough studies exist on postural reflexes at this time of life. Dr. Mittelmann's study is useful in helping to find out in which type of children irregularities of postural reflexes occur. His finding that irregularities in posture are coupled with other disturbances in motility corresponds closely with my own experience. If Dr. Mittelmann's study is correct, one can use these reactions to establish specific types of motility in preadolescence. At this time there is a revolution not only in regard to motility but in regard to the glands of internal secretion. It is of interest that glandular disturbances are present in cases in which there is disturbed development of motility. It is difficult to determine whether the disturbances of motility are primary or secondary to the glandular disturbances. I am inclined to believe that the two disturbances are coordinate. I do think, however, that the endocrine factor may have an additional influence on the deterioration of motility.

One would expect disturbances of this kind to be combined with changes in the structure of the personality. They are bound to evoke emotional reactions. A glandular dysfunction in these cases does not create conflicts but makes them more obvious.

I am not sure now how to classify the hyperkinesis in the cases now described. Hyperkinesis in children is common. It is a behavior pattern in children which can be activated from many sources. It might be due to an endocrine disturbance, or it might be a reaction to a psychologic conflict, or the expression of a specific motor constitution or the result of an encephalitic process. On the

physiologic background, which Dr. Mittlemann has correctly described, psychologic conflicts of all kinds are reenforced. One additional factor deserves special attention, and that is that biologic deviation changes the appearance of the body. Children grow fat and have small genitals. Their body image (postural model of the body) is changed, a fact of special importance from a social point of view. People live in society not only as psychic personalities but as persons with a specific body. The attitude of society toward a person's body has a decided influence on his attitude. The knowledge of one's own body is not merely based on one's own experience but is the result of social intercourse. In Dr. Mittelmann's cases the body image is changed in that these boys realize or are made to realize that they are too fat and that their penis is too small. Both facts are of equal importance. What from the analytic point of view is called the castration complex should perhaps better be called the complex of the integrity of the body image. The integrity of sex parts, to be sure, is an important concern. The sex parts, however, are a part of the total body image which one wants to preserve. The body image is not static but is a dynamic development. Motility plays an important part in this dynamic development. When human beings are understood as social units in continuous contact with each other and under the influence of the opinions of others concerning their bodies, then one will understand the psychology in these cases.

Dr. D. M. Levy: I have studied 33 male patients with Fröhlich's syndrome at the Institute for Child Guidance. There are certain differences between this group and the group of patients of Dr. Mittelmann. The patients at the institute were referred there not because of any physical complaint but because of behavior problems. The diagnosis of the Fröhlich syndrome is often questionable. The differentiation between generalized obesity and a Fröhlich type of obesity may be difficult. For instance, in reporting on the same patient, one of the two examiners at the institute, would observe that this is rather a hypopituitary type of obesity, while the other would call it "generalized obesity." It was important to select only cases in which mons-mammary-girdle adiposity was well defined. On this basis, the type of distribution of fat was the one sign present in every case. The finding of hypogenitalism was not considered essential in the diagnosis. Twenty-eight of the 33 patients at the institute were classified has having hypogenitalism. In 18 cases the penis was small but the testes were normal; in 10 cases both the penis and the testes were small. I should add that obesity was not present in 4 cases, since a typical distribution of fat may be present without obesity.

By ordinary neurologic examination, clumsiness was not revealed as a predominant type. The studies on postural reflex described by Dr. Mittelmann were not made. Again I want to emphasize that, unlike Dr. Mittelmann's group, the patients at the institute were not referred there because of physical complaints.

In regard to the metabolism test, I hoped that Dr. Rowland Freeman, who made a number of such tests, would be here to discuss the findings. In 16 cases the rate ranged from $+31$ to -16, the mean being -1; in the majority it was within normal limits. It is well known that determinations of the metabolism rate in children are less reliable than in adults. The difference in Dr. Mittelmann's findings may be due to his extra care and precision and to the fact that he threw out ratings which he decided were inaccurate because of the restless behavior of the patient during the test.

The ages of our patients varied from 7 to 19 years, the median age being 12. They were under observation from two to four years following the initial examination.

Treatment with an extract of the urine of pregnant women was not used. Pituitary extract or the anterior pituitary-like gonadotropic hormone from the urine of pregnant women was administered by mouth and hypodermically. A number of the treatments were controlled by Dr. Rowe of the Evans Memorial Hospital in Boston. In regard to the effect on the behavior of the patient, and, in fact, on the growth of the genital organs, I found no difference in the treated

and untreated groups. Also, all patients, regardless of treatment, showed evidence of pubescence when the age at the time of reference was 13. In the treated group there was no instance of marked acceleration of growth but, as in the others, a gradual change.

In regard to the psychologic aspect of the cases, my interest was aroused because, as compared with the large number of patients at the institute the group of patients with Frölich's syndrome showed a high proportion of problems in submissive behavior. Most of the children who were sent to the institute had difficulties easily classifiable as problems in aggressive behavior, whereas the majority of those with Frölich's syndrome showed problems in submissive behavior. Is this submissive response to be explained as a psychic reaction to the obesity, hypogenitalism and clumsiness? Dr. Mittelmann's classification of the responses of his patients covers, in the main, all the possible responses to any deformity. Given any disability, a child may accept it, rebel against it or remain indifferent. The problem is: Why does this group show a prevailingly general submissive reaction? That question can be studied in a number of ways. One can select children according to their weights, divide them into groups representing degrees of overweight and see if there is a correlation of obesity and the submissive pattern. When this is done, no significant difference is found in groups of boys ranging from 20 per cent below to 40 per cent above the median weight for age and height in regard to submissive or aggressive factors. The obesity in itself, therefore, does not explain the submissive direction. Nor, according to my studies, is it explainable by the factors of energy or response to small genitals. Furthermore, when studies of the life history are made in order to evaluate those experiences which favor submission, again there appears no essential difference in this group as compared with others. One concludes, therefore, that the submissive pattern of the group with Fröhlich's syndrome is due not to psychic response to anatomic variations or to special emotional experience but to constitutional (endocrine) factors.

DR. BELA MITTELMANN: I may add to Dr. Brill's description of Napoleon that he had no hair on his chin and that he was obese. I do not remember how many inches of pubic fat the coroner had to cut through in performing the autopsy. Thus, Napoleon conformed closely to the picture presented by a patient with adiposogenital dystrophy.

The problem of hyperkinesis is unsolved. There is no question that there is an organically and a psychogenically determined form. The only way one can settle the matter in a given case at present is by observing the child and by taking the history into consideration. Hyperkinesis starting from infancy, before an intense traumatic psychic factor could have appeared in the life of the child, or following febrile disease or encephalitis is to be considered organic. The response to treatment is another criterion. Hyperkinesis which does not yield, even for a short time, to psychotherapy, in spite of good contact between the therapeutist and the patient, is of organic origin. The patient presented made an excellent contact with me, but he could not be quiet for one minute during interviews. Whenever he sat down with me, after about half a minute his hands would be wandering to some object on my desk. This fact, together with the beginning of overactivity in infancy, stamps the condition as organic. This decision is important for prognosis. The correction of the endocrine condition did not alter the hyperkinesis, and psychotherapy was useless. The patient is in jail now; if he is discharged he will go back there again.

Dr. Levy's points are interesting. The source of material for study is important. Certainly if one studied adiposogenital dystrophy in a neurosurgical ward one would find entirely different problems than in cases in which neoplasm is not involved. One would have the blindness and other signs of an expanding lesion.

There is no question in my mind that the management of the child by the parent has an important bearing on the reaction of his total personality to his deficiencies. One of the boys presented, whose endocrine status later cleared up

completely, had been of submissive type up to the age of 9. Then the passive feminine adaptation failed. He became aggressive; his aggressiveness and hostility were directed mostly toward his mother. He attacked other people and also the younger children with whom he played. His basal metabolic rate was still —14. He also had a tremor of the hands, which persisted after correction of the endocrine symptoms and after genital development and metabolism became normal. His mother paid particular attention to this tremor. The child would not eat in the presence of strangers, to hide his deficiency. His mother would persuade him to eat. She would watch him and tell him not to be "nervous." After such episodes the child would become abusive and disobedient. Finally, I prevailed on the mother to pay no attention to the tremor. Since, she has left him alone and they get along better. The patient has learned to cope with his deficiency, after the parental attitude had been corrected. The development of an adequate transference was another factor.

NEW YORK ACADEMY OF MEDICINE, SECTION OF NEUROLOGY AND PSYCHIATRY

Oct. 8, 1935

ABRAHAM A. BRILL, M.D., *Secretary*

LEON H. CORNWALL, M.D., *Chairman*

METASTATIC MELANOMA INVOLVING THE CENTRAL NERVOUS SYSTEM. DR. HERMAN WORTIS and DR. S. BERNARD WORTIS, New York.

This article with its discussion will appear in full in a later issue of the ARCHIVES.

NEUROMYELITIS OPTICA: REPORT OF A CASE. DR. E. D. FRIEDMAN, New York.

Elaine W., a schoolgirl aged 9 years, had a family and a previous history that were irrelevant except that since August 1932 she had been suffering from a furuncle on the outer aspect of the left leg near the knee joint. The present illness is said to have begun on Oct. 9, 1932, when the patient complained of pain in the back between the shoulder blades. The next day she was seen by Dr. Murray Bass, whose physical examination revealed completely negative results. The pain, however, continued. On October 11 it was followed by pain in the abdomen and vomiting. The child was seen by her family physician, who thought that the condition was acute appendicitis. The patient was operated on on October 12. The next day she complained of numbness of the legs and increasing pain in the back. Even prior to operation she had spoken of some pain in the back of the neck. The postoperative course was marked by vomiting and continuous pain in the back. On October 16 the patient complained of inability to move her arms, but the next day this symptom subsided.

Physical examination on October 17 revealed normal pupils and fundi. There was no nystagmus. The extra-ocular muscles were normal; in fact, there was no evidence of involvement of cranial nerves. There was complete paralysis of both lower extremities, with absence of abdominal reflexes, loss of knee and ankle jerks and a Babinski sign bilaterally. The deep reflexes in the upper extremities were present, but diminished. There was a sensory level at the fourth dorsal segment, below which all forms of sensation were abolished. The patient was incontinent. The spine was diffusely tender in the lower part of the cervical and the upper part of the dorsal region, but no infiltration of the tissues was detected. There was some rigidity of the neck, and the patient resisted anterior flexion of the head owing to great pain.

Lumbar puncture revealed clear colorless fluid, with 26 lymphocytes per cubic millimeter; there was no evidence of block or of other abnormalities.

Roentgen examination of the spine gave negative results.

The diagnosis was a transverse lesion of the spinal cord at the level of the fourth dorsal segment. The question of an osteomyelitic focus in the course of staphylococcic sepsis, with epidural suppuration, was considered but deemed improbable.

The symptoms slowly subsided. Power returned first in the left lower extremity and later in the right. The function of the bladder improved, and on November 10 the father reported that the child was at home and doing well.

The patient was seen again on December 30 (two and one-half months later), when she complained that about a week previously she had noted impairment of vision in the left eye, which quickly progressed to complete amaurosis; the right eye was normal.

Physical examination at the time revealed a sluggish right pupil and a fixed left pupil. There was complete amaurosis in the left eye, with loss of consensual reaction from illumination of this eye. The right fundus was normal; the left showed swelling and hyperemia. There was no other evidence of involvement of cranial nerves. There was no motor weakness. The abdominal reflexes were more active on the left. The deep reflexes in the lower extremities were exaggerated, and there was a Babinski sign bilaterally. The sensory disturbances had disappeared, and the bladder was functioning normally.

The patient was then admitted to the Beth Israel Hospital. On Jan. 3, 1933, it was noted that vision in the right eye was rapidly failing, so that the patient barely perceived light.

Roentgen examination of the skull gave negative results. Examination of the spinal fluid again revealed 23 cells, but no other abnormalities. A blood count gave normal results. The urine was normal.

Vision rapidly failed in the right eye. There was some preservation of vision in the nasal field (chiasmal lesion?). Illumination of the right pupil from the temporal side gave no response, and from the nasal side, a slight response. There was swelling of the right disk. The left pupil began to respond to light.

On January 12 there was practically complete amaurosis of the right eye, with fixation of the right pupil. The left pupil responded fairly well, and vision returned to the extent that the patient was able to count fingers at from 8 to 10 inches (20 to 25 cm.). Blurring of the disks continued. (The ophthalmologist found swelling of 3 diopters in the right eye and of 2 in the left eye.)

On January 18 the right pupil began to respond to light; the disks were still blurred. Vision improved in the left eye so that the patient was able to read large type.

On January 28 in was noted that for the last few days the patient had been complaining of numbness of the right side. Mild disturbances in pain and temperature sense were demonstrated on the right up to the level of the fourth dorsal segment; there was motor weakness on the left (Brown-Séquard syndrome). The changes in the optic nerve were recessive. There was now some pallor of the left disk, and examination of the visual fields showed central scotomas in both eyes.

On January 30 the patient spoke of transient paresthesias of the left hand and weakness of the left upper extremity.

On February 1 phenomena made their appearance indicating a sensory level at the first dorsal segment. There was paraplegia with a Babinski sign bilaterally and diminished abdominal reflexes. The patient had difficulty in voiding urine. Vision improved steadily.

On February 3 the sensory level rose to the fifth and sixth cervical segments. Sensory changes referable to involvement of the posterior column developed, and tactile sense was lost on the left.

On February 4 there was a suggestive Horner syndrome on the right. There was no impairment of breathing or signs of bulbar involvement. The temper-

ature was normal, but the pulse rate was rapid (120). The biceps jerks subsequently disappeared. Sensory changes in the arms made their appearance (especially those indicating involvement of the posterior column). Stereognosis was lost in both hands. There were no phrenic or bulbar phenomena.

On February 15 hiccup developed. The sensory level still remained at the sixth cervical segment. The biceps jerks were present, but the triceps jerks were absent. The ankle jerks were active, and there was a Babinski sign bilaterally. The abdominal reflexes were not obtained, and there was absence of the knee jerks. Vibration and position sense were somewhat improved in the left upper extremity.

On February 18 the patient was discharged from the hospital. At this time there were a residual Horner syndrome and slight blurring of the disks with pallor, especially on the left. There was no other evidence of involvement of cranial nerves. There were no bulbar or phrenic phenomena. Motor power in the arms had improved, especially on the left. There was some atrophy, however, in both forearms and hands. The lower abdominal reflexes were feebly present. The knee jerks were diminished, and the ankle jerks were active. There was a Babinski sign on both sides. The sensory level persisted at the fifth and sixth cervical segments, and the sensory disturbances included the perianal zone.

On March 15 the patient was somewhat improved; strength was returning in the arms and legs; vision was unchanged. The function of the bladder was nearly normal.

About two weeks later the symptoms grew worse. Fever (temperature from 100 to 101 F.) developed. Quinine therapy, which had been carried out previously, was again resumed (3 grains [0.19 Gm.] three times a day).

The patient did fairly well through the summer of 1933, although the power in the legs was poor and the left arm was impaired. There subsequently developed flexor contractures of the arms and legs, and the condition grew progressively worse.

On March 28, 1934, the following conditions were noted: marked amblyopia; bilateral atrophy of the optic nerve, with practically fixed pupils; absence of other evidence of involvement of cranial nerves; absence of phrenic phenomena; complete paraplegia in flexion, with flexor contractures of the arms as well; absence of abdominal reflexes; presence of ankle jerks; a Babinski sign on the left; loss of sensation, involving all forms, up to the second or third cervical segment; incontinence of urine, and bed sores.

Lumbar puncture revealed no evidence of block, and the cell count was normal. The patient was discharged from the Neurological Institute on April 2 and died soon afterward. Permission for postmortem examination was not obtained.

A specimen of the spinal fluid sent to Dr. Leslie T. Webster, of the Rockefeller Institute, revealed no evidence of virus infection.

Comment.—The condition in this case is an example of the clinical syndrome known in the literature as neuromyelitis optica, or Devic's disease. The classification rests more on clinical grounds. The condition is probably an infection of the central nervous system due to a neurotropic virus, with localization of the lesions in the spinal cord and in the optic nerves, chiasm and tracts. The morbid process in the optic nerve is in the retrobulbar portion. It differs from the picture of retrobulbar neuritis encountered in multiple sclerosis by the presence of edema and swelling of the disk.

A similar clinical syndrome was first described by Allbutt, who in 1870, reported a case of acute bilateral optic neuritis associated with acute myelitis. In 1894 Devic called the condition *neuromyélite optique aiguë*. Relatively few cases have been noted in the English literature, although Holden reported 5 cases of acute myelitis with retrobulbar inflammation of the optic nerves. He stressed the fact that in one half of his cases there was lateral hemianopia in one eye alone, just as in our case. This probably indicates partial involvement of the chiasm. In some instances it would appear as though the optic nerves themselves bear the brunt of the inflammatory process. Usually both eyes are involved,

but not always simultaneously. The loss of vision is rapid, just as in other forms of retrobulbar neuritis, and the process heals with residual atrophy of the optic nerves.

Salvati recently described a similar condition, occurring in a girl aged 14, who suffered from fever, pain in the joints and transient paralysis of the lower limbs and bladder. The latter subsided in two weeks. Five days later vision in the left eye was abolished. Three days later vision was lost in the right eye. One week later vision returned in the left eye, and five days later it returned in the right. Two weeks later vision was limited to the counting of fingers, and examination of the visual fields showed central scotomas inside of 20 degrees. There was secondary atrophy of the nerve heads. Salvati collected reports of 50 similar cases from the literature. In his own case the symptoms indicating involvement of the spinal cord developed first, as in our case. Some cases have been reported in which there was unilateral amblyopia. In 50 per cent of the cases the condition proved fatal. Postmortem examination in 15 cases showed interstitial inflammation of the optic nerves and an inflammatory process in the spinal cord with degeneration of nerve fibers.

DISCUSSION

Dr. Israel Wechsler: I can confirm every word of Dr. Friedman's discussion. I wonder, though, if one is justified in making a clinical entity of this condition. Dr. Friedman has well said that it belongs in the group of neuromyelitis or encephalomyelitis. From the literature I gather that the ocular symptoms usually precede the symptoms of involvement of the spinal cord. I wish to call attention to the fact that ocular changes occur commonly and are frequently overlooked in cases of multiple sclerosis. Retrobulbar neuritis occurs much more frequently in cases of multiple sclerosis than a description of such cases would indicate. If careful examinations of the eyes were made one would find scotomas in cases in which there are apparently no clinical symptoms or clinical disturbances. It is possible that in the case of Dr. Friedman there is a transitional state between multiple sclerosis and disseminated myelitis. The earlier cases were described at a time when not enough was known of the pathology of multiple sclerosis and comparatively little was known of virus disease. In the group of encephalitides there may be selective affinity for the optic nerve and the spinal cord. The only comment I can make is to question whether one ought to continue to diagnose as an entity a condition which is fairly discrete but probably belongs in the group of encephalomyelitides and perhaps has a relation to multiple sclerosis.

Dr. Marcus Neustaedter: My associates and I are now working on a case in which a diagnosis of neuromyelitis optica or tumor of the spinal cord was made in Dr. Kennedy's service at the Bellevue Hospital; necropsy was performed by us at the Neurological Hospital. The case is that of a Negress, aged 35, who had had grip nine months before admission to the hospital. Two or three weeks later she became paralyzed in the lower extremities. She complained of numbness in the feet, which gradually ascended as far as the tenth dorsal segment, as I recall from the report which we received from the Bellevue Hospital a few weeks after our examination. The patient was then sent to the Neurological Hospital. When she came there she had a definite sensory level at the twelfth dorsal segment, with complete analgesia and thermanesthesia in both lower extremities and retention of touch. Spinal tap at that time showed the pressure to be 10 mm. of mercury; it rose to 14 mm. on compression of the jugular vein on each side and to 18 mm. on compression of both jugular veins and then slowly receded to 10 mm. We thought that there was a questionable Queckenstedt sign, and I suggested a possible diagnosis of central gliosis. The spinal fluid showed a low cell count. The optic disks were pale. There did not appear to be secondary atrophy of the optic nerves, as the borders were clearly defined. Vision could not be tested because the patient was bedridden. She had spastic paraplegia, with

Babinski phenomena and all the other confirmatory signs, and clonus bilaterally. She was also incontinent. I believe that at the time that was the main reason which led me to think that the case was not one of multiple sclerosis. I suggested laminectomy, but the patient refused to grant permission. To my surprise I saw that at the Bellevue Hospital a note had been made that she had also refused permission for laminectomy to be performed there.

After five months the temperature and pain sense completely returned, and sensibility was not much affected. Paralysis of both lower extremities remained as in the beginning. In January 1935 the patient contracted pneumonia and died on January 6. An autopsy was performed, and offhand I can say that there was involvement of the lateral tract all the way down from the dorsal region, but there was a reactionary inflammation involving the entire cerebrospinal axis, the cortex, the basal ganglia, the pontile region and the bulb and also the spinal cord. There was an inflammatory involvement of both optic nerves. The diagnosis after that was changed to encephalomyelitis with involvement of the optic nerves, and I believe that is as much as any one can say.

Dr. Friedman is right when he says that neuromyelitis optica is not a pathologic entity, as there is an inflammatory reaction, but it is not always a clinical entity. The literature is full of reports of such cases during an epidemic of poliomyelitis and also during an epidemic of encephalitis, with more or less encephalitic changes prevalent. I shall present the pathologic observations in our case at a future date. Of course, the condition might be compared with acute ascending paralysis, the so-called Landry paralysis, which is a distinct clinical entity but not a pathologic entity. In that one might have any virus as an etiologic factor. I remember the case of a patient in the Kings County Hospital in whom the condition began with a syndrome of syringomyelia. I think that in such cases one is perfectly justified in the diagnosis, and in the Neurological Hospital, at least in this case, a diagnosis was made of encephalomyelitis with symptoms referable to the optic nerve.

Dr. Foster Kennedy: I have had some interest in this subject, having observed 8 cases in which the condition was striking in the malignancy of its course and in the benignness of the results. The patients had acute retrobulbar neuritis with amaurosis, fixed pupils and evidence of acute edema of the disks, followed by atrophy of the optic nerve, with an amazing return of vision in an eye which was ophthalmoscopically blind with a perfectly white disk. There were also changes referable to the spinal cord, which I was interested to hear Dr. Neustaedter say represent the syndrome of acute syringomyelia—changes which symptomatically were referable only to the middle of the spinal cord, with retention of the posterior column representation and negation of the central sensations: pure syringomyelia of acute onset.

I wish to mention especially 1 case, in which there were signs that are almost incredible. Several men here, however, will vouch for the truth of what I say! The patient, a woman, in December 1932 became blind in one eye, and two days later she was blind in the other eye. There was a retrobulbar neuritis with amaurosis, which was thought to be due to a diseased sinus. An operation was performed, but the sinus was normal. The patient was brought to New York from her home in the country and was thought to be exhausted. She was examined and found to have an acute lesion of the spinal cord at the level of the nipples, the symptoms indicating involvement of the central portion of the cord. When I examined her I said that the case was one of acute ependymitis—an acute inflammation of the central canal of the spinal cord. The deep reflexes and the plantar reflexes were absent; there were total flaccid paralysis and complete incontinence. The upward progress of loss of sensation occurred in a few days, and both arms became flaccidly paralyzed. The arms began to get better, and then the legs began to improve. Three weeks later there was involvement of the pontile region. By this time the patient was blind, with paralysis of both sides of the face, paralysis of the tongue and paralysis of both sides of the neck. She

was fed by tube, and was nearly dead. She then became totally deaf. When she came for consultation she was totally deaf, totally blind and totally paraplegic.

She was beginning to get better from the paraplegia, when her face became completely paralyzed. She recovered a certain amount of power in the legs and then had a lesion of the midbrain, with total paralysis of the ocular muscles of the eyeballs from which she recovered. A few weeks later she had an insult in the left cerebral hemisphere, which produced hemiplegia in the right limb, which was recovering from the paralysis, with aphasia—a clear and complete aphasia. A few weeks later, having recovered from that in the course of three weeks, she had left hemiplegia of the cerebral type, with, of course, a superimposed pseudobulbar palsy. In the course of eight weeks she recovered a certain amount of vision. She has at present perfectly white disks and 50 per cent vision, adequate for reading and for getting about. Hearing is normal, and there is no objective or subjective evidence that anything was ever the matter with her arms, legs or voice. It is an almost unbelievable story. The case is, I believe, similar to that which Dr. Friedman has reported. I can cite a number of other cases which have been almost as dramatic as that one. It must be that the lesion produced a complete block physiologically but not anatomically. The condition must be some form of edematous infiltration of tissues, interrupting transmission of impulses without solution of the continuity of the tissue. I believe that the condition is due to virus infection. Dr. Samuel Wortis will tell of a patient of ours, a boy, who had similar symptoms and whose spinal fluid was subjected to a number of passages in rabbits.

Dr. S. Bernard Wortis: From what little is known of virus diseases today, for example poliomyelitis, it has been learned that most viruses are bound in the spinal cord or brain tissue in the cells of that tissue. For example, if poliomyelitis virus is injected into monkeys and the spinal fluid is drawn from the poliomyelitic animals in the acute stage and injected into normal animals, these animals will not show the virus disease. The virus is bound in the cells. However, emulsions of poliomyelitic spinal cord will contain the virus and reproduce the disease. Recently, Rivers and Scott have shown that the spinal fluid in cases of virus meningitis contains the virus in active form. Spinal fluid taken from human beings with poliomyelitis reproduces the disease when injected in mice and monkeys.

The case mentioned by Dr. Kennedy was that of a boy who was seen at the Doctors' Hospital. He had atrophy of the optic nerve and convulsions. We were able to obtain material from the frontal sinuses and passed it through a filter; the filtrate was found to be sterile by the usual methods of bacteriologic culture. However, intracerebral injection of this material into rabbits and monkeys caused convulsions and lesions of the spinal cord. We were able in this case to isolate a virus which when transmitted to animals produced signs of involvement of the cerebrum and spinal cord. As yet we have not been able to identify the virus. I wish to ask any one who observes a patient with a similar condition who comes to autopsy, so that samples of spinal cord or brain can be secured, to send the specimens to us for study in an effort to determine the virus etiology.

Dr. A. M. Rabiner: A number of years ago Dr. Strauss and I reported a group of cases of a condition which was designated as myeloradiculitis. In some respects Dr. Friedman's case and the others cited tonight could be included in that series. Reports of numerous similar cases are to be found in the literature; among them, those designated by Dr. Foster Kennedy as instances of infective neuronitis and those reported under varying titles by Bradford, Bashford and Wilson, Casamajor and others. The condition in these cases is characterized first by multiplicity of lesions and second by the fact that remissions and exacerbations often occur. In these respects it certainly resembles multiple sclerosis. The pathologic condition also suggests multiple sclerosis, depending on the time when the lesions are examined. One of the patients whose cases we reported returned some time later and on examination presented a picture typical of a parkinsonian syndrome. This seems an important factor in suggesting that the

underlying etiologic virus resembles or is identical with that of epidemic encephalitis. Different strains of the virus produce protean symptomatology with varying degrees of virulence. Thus, in some cases there is an acute fulminating course, while in others the disease is chronic and in many there is complete recovery.

DR. E. D. FRIEDMAN: I think that Dr. Wechsler will agree with me when I say that the ocular changes in this case are certainly not those usually encountered in cases of multiple sclerosis. In such cases there is usually a history of acute amblyopia with no apparent objective change in the fundus of the eye; the lesion is almost always unilateral. The amblyopia usually lasts two or three weeks and then subsides. One can frequently demonstrate central scotomas. In my case, on the other hand, the bilaterality of the involvement and the rapid march of events, the recession in one eye and the implication of the other eye speak rather in favor of an inflammatory process which extends across the optic chiasm and gives this clinical entity its name, neuromyelitis optica. Those who have had experience with cases of this condition will recall instances in which ocular symptoms alone were present, without symptoms of involvement of the spinal cord. All have encountered cases in which there were pronounced changes in the fundus which were ascribed to sinusitis; the sinuses may or may not have been exenterated. The symptoms improve, and one is often at a loss to know what the etiology was. In my opinion these are cases in which there are circumscribed lesions in the optic nerves and chiasm.

With regard to Dr. Kennedy's remarks, may I say that Dr. Kennedy has reported a number of instances of the syndrome of acute ependymitis. I do not believe, however, the condition in my case is of the same type, because involvement of the posterior columns was demonstrated. In most of these cases it is the long white fiber tracts which are involved and seldom the central gray matter. Of course, one might visualize concomitant edema of the central gray matter, but essentially these are demyelinating diseases, especially involving the lateral columns and the spinobulbar pathways. The patchy character of the lesion is much like that seen in multiple sclerosis. I am not prepared to deny the existence of the clinical entity acute ependymitis, but I do not think that the condition in the case I described fits in with that picture.

I am familiar with Dr. Rabiner's paper on myeloradiculitis. The entire literature on this subject seems to emphasize the fact that one is dealing with a diffuse lesion of the central nervous system which involves the nerve roots, the long fiber pathways and the basal ganglia. It is a far flung infection of the nervous system. In Dr. Kennedy's case of myeloradiculitis with parkinsonism it may be that the virus is in some way related (if not of the same species, at least of the same genus) to that causing epidemic encephalitis. I think that one may safely say that these cases are instances of a virus infection and that on the neuro-anatomic and neurophysiologic units involved will depend the clinical entities produced.

THE EFFECTS OF LESIONS OF THE SUPERIOR CEREBELLAR PEDUNCLE IN MACACUS RHESUS MONKEYS. DR. A. FERRARO and DR. S. E. BARRERA, New York.

This report is a summary of the results of partial and complete unilateral and bilateral lesions of the superior cerebellar peduncle produced in 23 Macacus rhesus monkeys. All lesions were studied by complete serial sections stained by the Weigert or the Marchi method.

Incomplete unilateral lesions of the superior cerebellar peduncle at levels near where the peduncle dips ventrally into the brain stem were associated with a greater or less degree of ipsilateral ataxia, dysmetria and hypotonia. Bilateral lesions of the same type were associated with the same symptoms, which, however, were present on both sides. Differences in the extent of the lesions of the peduncle on the two sides apparently produced no noticeable differences in the intensity of the symptoms on the two sides. When the lesion was confined to

the superior cerebellar peduncle and did not involve the complete peduncle there were no symptoms which could be interpreted as indicating vestibular involvement, those that were present being what are usually termed the cerebellar type.

After the presentation of material dealing with the most usual type of symptoms, an unusual case was presented in which anatomically complete degeneration of one superior cerebellar peduncle was present. In this case there was not merely a section of the peduncle but a caudocephalic punching out of the peduncle was accomplished, and preparations stained by the Weigert method revealed complete degeneration of the peduncle on that side. No direct lesion of the juxtarestiform fibers or vestibular nuclei could be detected on careful study of serial sections. Symptomatically, in addition to the ipsilateral hypotonia, hyporeflexia and ataxia or dysmetria, there was a group of symptoms which could practically be superimposed on the symptoms found in association with large unilateral lesions of the vestibular nuclei. The symptoms which were interpreted as vestibular consisted of asymmetries in posture, including torsion of the chin toward the opposite side, relative ipsilateral flexion of the limbs and contralateral extension, nystagmus toward the opposite side, rolling movements toward the side of the lesion in the acute phase and spiraling toward the side of the lesion on jumping. The animal was severely disabled in the acute phase. At the five day period, a rather severe tremor developed which was confined to the head and limbs ipsilateral to the lesion. The tremor was of the flexion-extension type and of a frequency of perhaps 60 to 70 per minute. It occurred with the animal at rest. The tremor persisted until six weeks after the operation and disappeared at the same time as did the spontaneous nystagmus.

The finding of vestibular elements in the symptoms added to those of the cerebellar type when the lesion involved a considerable portion of the superior cerebellar peduncle in a caudocephalic direction suggests the presence in the peduncle of fibers of vestibular origin, at least for a certain portion of its length. This has been suggested by Winkler. An accurate explanation of the phenomena observed in these cases, which were portrayed with moving pictures, awaits further experimentation on the peduncles in addition to minute experimental anatomic exploration of the central vestibular mechanisms and the study of the associated symptoms. This work is being carried out at present in the laboratory.

DISCUSSION

DR. HENRY ALSOP RILEY: I think that it is extremely difficult to present an adequate discussion or worth-while consideration of a paper of this kind without intensive study of the material for some time. The authors have spent weeks and months operating on these animals, have studied their symptoms and have performed autopsies. They have examined the sections and then have tried to compare what they saw in the clinical animal, what they know they did in the operation and what they saw in the anatomic preparations. After they have spent all of this time on this study there is still some slight uncertainty as to exactly what this condition of affairs is. Then some one is asked to read the paper and discuss it in a constructive manner. I feel inadequate to do justice to the paper and the material.

In connection with this discussion, I remember some ungracious remarks I made one or two years ago to Dr. Fulton when he reported here in New York some of the results of his massive operations on the nervous system in which he removed considerable quantities of one or both frontal lobes and corresponding quantities of the cerebellum and then tried to analyze what had happened to the animal and what parts of the resulting behavioral deficit had been contributed by each of his operations. I suppose that the operative method will have to be the method of investigation of the nervous system. It seems to me, however, that it is an artificial method and has certain inherent defects which perhaps will never be entirely overcome. Certainly this must apply to the large ablations and deforming operations performed on the nervous system by some investigators,

in which a sixth or an eighth of the nervous system may be removed, with all that that means in regard to disturbances of complex and interrelated functions and systems of neural hierarchies.

I do not feel exactly the same way in regard to the work of Dr. Ferraro and Dr. Barrera. In looking at the sections and in looking at the illustrations I do not think I have ever seen more beautifully localized and limited lesions than those which they have made, and it is the case not only with these preparations but with others which they have shown on previous occasions. But even in these limited operative procedures, in which Dr. Ferraro and Dr. Barrera believe that they have destroyed only the superior cerebellar peduncle, it is self-evident that more neural tissue must have been damaged in reaching and making the experimental lesion. To gain access to the superior cerebellar peduncle in the location where the section was made it is necessary to enter the fourth ventricle, to incise the lateral wall of the fourth ventricle, to cut fibers which are situated in the periventricular region and then at considerable depth to reach the superior cerebellar peduncle, which is deep in respect to many important and significant structures. In the immediate vicinity of the superior cerebellar peduncle is a mass of gray matter which surrounds it. Still farther dorsal is the ventral spinocerebellar tract, and ventral to the region that is approached with the knife is the dorsolateral angle of the tegmentum with all the vestibular complex, the dorsolateral bundle of the tegmentum and numerous other structures. It is impossible for a pure lesion of the superior cerebellar peduncle to be produced by any operative procedure of this kind. What the authors mean, I believe without question, is that it is relatively a pure lesion.

The sections which I saw and the illustrations which Dr. Ferraro gave me interest me particularly from the anatomic standpoint, and in looking at them from the purely anatomic standpoint I could not and I cannot accept what Dr. Ferraro and Dr. Barrera say, that is, that there is no lesion of the vestibular complex. I did not see a complete set of sections. I did not see sections considerably below those presented, but neither Dr. Ferraro nor Dr. Barrera was able to convince me that there was no vestibular lesion. I am sure that there is.

The complexity of the function of the structures in this vicinity and the difficulty in interpreting results of operative destruction in this locale are well illustrated by the statement made by the authors, namely, that a lesion of the juxtarestiform system will give rise to vestibular symptoms in one direction, whereas a lesion of the vestibular nuclei, the nuclei from which is derived this same juxtarestiform system and only separated perhaps 2 or 3 mm. from it, causes such symptoms as turning, falling, rotating movements, nystagmus, etc., in the opposite direction. I have no idea what the explanation for these opposite results may be.

The other feature that interested me was that the tremor which developed after the section of the superior cerebellar peduncle is exactly the same type of tremor which Dr. Brock and I found in the rhythmic myoclonus of the palate and pharynx and sometimes of the upper extremities, which developed as a result of pathologic processes within the neuraxis and the cerebellum. It has been shown pathologically that in these cases of rhythmic myoclonus the lesions involve the dentate nucleus, the superior cerebellar peduncle, the central tegmental tract or the red nucleus. There is one important difference, however; the tremor is continuous and persists as long as the patient lives, continuing even during sleep.

I cannot close without again saying how much I believe is being accomplished by this type of experimental investigation, and again I will say that I have rarely seen such beautiful preparations or so clean or limited lesions as Dr. Ferraro and Dr. Barrera have shown.

Dr. Kurt Goldstein: The authors themselves have pointed out that their investigations do not offer so much definite results as material for further investigations. Everybody who knows the complexity of the cerebellar and the vestibular apparatus will understand that one cannot sufficiently appreciate that

the authors have presented the problem in question so clearly on the basis of their minute operations.

The case reported, in which a circumscribed complete lesion of the superior cerebellar peduncle was associated with combined cerebellar and vestibular symptoms, might prove that the superior cerebellar peduncle does not contain the same fibers at different levels. The vestibular symptoms may have been caused by a lesion of supravestibular fibers, possibly situated in the ventral part of a more caudal portion of the superior cerebellar peduncle. That is made probable by the fact that lesions of the dorsal portion of the superior cerebellar peduncle and of the peduncle at higher levels do not give rise to vestibular symptoms. The facts make it probable that the vestibular fibers have left the superior cerebellar peduncle before the higher levels were reached. I may mention that a thorough study of the preparations of the authors, which I had the opportunity to make, allows me to state that the nucleus vestibularis was not damaged.

The result of the authors challenges one to give up the merely topographic conception of superior cerebellar peduncle and to distinguish in this tract different systems. This is an important result because it lays down a basis for understanding and eliminating the confusion which exists about this problem in the literature.

An interesting result to me is the appearance of tremor in the case in which there were cerebellar and vestibular symptoms and particularly interesting is the fact that the tremor and the nystagmus disappeared at the same time. On another occasion I pointed out that tremor and nystagmus are disturbances of similar kinds, that they are the expression of the coming into effect of two antagonistic impulses in one system. The one impulse—the peripheral one—is given in the increase of draught of tone toward the side of the lesion. The second impulse is formed by the central component, in the voluntary or static innervation. The combined lack of cerebellar and vestibular function increases this draught of tone to such a degree that the antagonistic nystagmoid effect becomes manifest, that is, the tremor. When the effect of the vestibular damage is about to cease—one can assume that this occurs when the nystagmus disappears—then the tremor also disappears, apparently because the increase of tone caused only by the lack of cerebellar function, by a lesion of the superior cerebellar peduncle, is not strong enough to effect an antagonistic impulse. I should like to hear from the authors if the tremor shows the character of a nystagmoid movement, that is, a slow and a quick component.

DR. ARMANDO FERRARO: In answer to Dr. Riley, I wish to emphasize that we ourselves were somewhat puzzled as to the existence and explanation of vestibular symptoms following considerable damage of the superior cerebellar peduncle. We were aware that the first objection to be brought up might be the one of a possible involvement of the vestibular apparatus and have therefore been careful in checking the existence of such a surgical complication. We do believe, however, from the study of our serial sections that we have actually no indication that a direct involvement of the vestibular apparatus is present in our material. We therefore believe that the vestibular symptoms which follow the lesion of the superior cerebellar peduncle may be the expression of an anatomic fact that in the superior cerebellar peduncle there are, in addition to fibers originating in the dentate nucleus and going to the red nucleus, fibers originating from another group of nuclei, the nuclei proprii of the brachium conjunctivum, which surround the superior cerebellar peduncle. We believe, as Winkler said, that possibly fibers from these nuclei enter the superior cerebellar peduncle to reach the mesencephalon. That the superior cerebellar peduncle contains fibers other than those originating from the dentate nucleus is substantiated by the ontogenetic development of myelinization. At a period when the fibers originating from the dentate nucleus are not myelinated, one does find myelinated fibers in the superior cerebellar peduncle. Such a fact opens one's mind to the possibility that in the superior cerebellar peduncle fibers are present which originate from other sources and the function of which is vestibular in type.

In our operative technic we have been able to reach the superior cerebellar peduncle at a more cephalic level than the I. A. K. bundle and we have found it possible technically to make a lesion of the superior cerebellar peduncle cephalad to the fibers of the I. A. K. bundle without necessarily damaging these fibers. On the other hand, from our past experimental work we know that if we do section the fibers of the I. A. K. bundle we produce different symptoms than those which have complicated the section of the superior cerebellar peduncle in the particular case under discussion. Such symptoms consist fundamentally of the vestibular type, a twist of the head and deviation of the chin toward the side of the lesion and nystagmus toward the same side. The direction of the chin and the direction of the nystagmus are therefore opposed to the direction of the chin and the direction of the nystagmus which we have found in the case under discussion. This is why we do not feel inclined to accept a possible complicating lesion of the I. A. K. bundle as the explanation of the vestibular component in the symptoms in our case. On the other hand, if the vestibular symptoms which we are reporting are the result of a complicating lesion of the I. A. K. bundle, it seems strange that in over 20 other monkeys no vestibular complication has been reported, though chances of involving the I. A. K bundle were as great as in the case under discussion. As mentioned before, we have no explanation to offer at the present time but the one of suspecting the possible course of fibers with a vestibular function in the length of the superior cerebellar peduncle and directed toward the mesencephalon.

Dr. S. E. Barrera: I have only one point to make in regard to the operative procedure and to the general effect of what was in the past rather poorly termed "shock." This is one of those vague terms like "inhibition," which, as Dr. Goldstein has stated elsewhere, is a corrective but nonexplanatory term dragged in to make up for a lack of knowledge concerning initial processes. In practically every case we open the fourth ventricle, manipulate the cerebellum carefully and in half an hour or so close the opening after making the lesion. We may make only a small lesion, which does not produce symptoms. In these cases, if we close the opening with the animal in deep anesthesia, it is up and jumping around and eating in about one hour. Key symptom-producing lesions may be effected, and in these cases the symptoms, which are usually fairly constant for certain lesions, can be clearly seen by about one hour after the animal leaves the operating table. I do not think that in general the handling of the brains in these procedures contributes much to the symptoms. It is rather a question as to the location of the lesion.

In reference to Dr. Goldstein's questions, I would state that as yet we have no definite knowledge of the relation of any particular portion of the superior cerebellar peduncle to the cerebellar cortex and thus to the limbs. It is possible that there are two components in the tremor such as are found in nystagmus, but we do not know. In the eye, gravity does not have any appreciable effect, and thus differences in speed of movement may be more easily seen and be of more significance, but in the arm mass and gravity probably play a considerable rôle. For example, if the quick component were upward with the arm in the usual dependent position, the possibility of its being clouded by or slowed up by the force of gravity must be considered. We have not investigated this interesting phenomenon as yet.

The Treatment of Dementia Paralytica by Electropyrexia Combined with Tryparsamide. Dr. Leland E. Hinsie and Dr. Joseph R. Blalock, New York.

The results of treatment for dementia paralytica by electropyrexia alone and in combination with tryparsamide have been a subject of investigation at the New York State Psychiatric Institute since June 1930. An ultrahigh frequency short radio wave electrical apparatus was used. Only adult patients with acquired dementia paralytica and positive changes in the blood who had had no previous

fever or tryparsamide treatment have been included. Over 140 patients have received nearly 1,400 individual fever treatments. Each patient received 10 treatments on alternate days, each consisting of an elevation of temperature above 102 F. for seven hours, the temperature usually being from 104 to 105 F. for most of the period.

There have been three research groups. The first group, totaling 68 patients, received fever treatments only; when surveyed six months later, 18 per cent had achieved a state of remission, 35 per cent were improved, 38 per cent were unimproved and 9 per cent were dead. These results are comparable to those obtained in a similarly large control group treated with malaria. The patients in the second research group were given a series of 10 fever treatments and then one or more courses (12 injections to a course) of tryparsamide combined with a bismuth compound. Of 27 patients, one year after termination of the fever treatment 37 per cent had achieved a state of remission, 33 per cent were improved, 26 per cent were unimproved and 4 per cent were dead. The patients in the third research group were given one-half dose (1.5 Gm.) of tryparsamide just prior to each of the 10 fever treatments, and then the treatment with tryparsamide and bismuth was continued as in the case of the second research group. It was desired to determine whether the clinical outcome might be different if thermotherapy was applied while tryparsamide was in the body. The findings of Fordyce and Meyers that seventy-two hours after injection of tryparsamide arsenic was no longer detectable in the spinal fluid, together with danger to the optic pathways, led to the adoption of a certain technic. This consisted of giving one-half dose (1.5 Gm.) before each fever treatment and giving these fever treatments twice instead of three times per week. Only 22 of 30 original patients completed the prescribed course of treatment. Of the 8 whose treatment was stopped, 3 acquired burns, 2 showed inability of the heart to meet the "heat load," 1 early became too agitated, 1 presented persistent vomiting and diarrhea and 1 complained of subjective visual disturbances. A survey of the 22 patients six months after completion of the fever therapy combined with tryparsamide showed that 27 per cent were in a state of remission, 37 per cent were improved, 32 per cent were unimproved and 4 per cent were dead. The single death was caused by pneumonia one month after the termination of the fever therapy.

Summary.—1. Fever electrically induced has a real therapeutic value, a value comparable to that of malaria. This form of fever is more easily tolerated by the patient than malaria, is more easily controlled and is accompanied by a lower mortality rate. Yet it cannot yet be stated that electropyrexia is as therapeutically effective as malaria.

2. Considerably better results are obtained when electropyrexia is used in some combination with tryparsamide. The results seem equally favorable whether the tryparsamide is given with each febrile reaction or merely continued after termination of the fever treatment.

DISCUSSION

DR. LEON H. CORNWALL: This report by Dr. Hinsie and Dr. Blalock is worthy of commendation. It represents an intelligent and critical analysis of results with artificial fever therapy combined with tryparsamide. The conclusions are characterized by a conservative attitude that is to be admired. It seems to me that one should have reason to expect that a combination of fever therapy with tryparsamide should be more effective than either form of treatment when given alone. The biologic mechanism involved is an intriguing problem, but I believe that complete ignorance prevails concerning this. There was a time when I thought that the amount of arsenic in the cerebrospinal fluid might be considered as a criterion of the effectiveness of treatment with the arsenicals. Several years ago Dr. Myers, Dr. Bunker and I investigated the arsenic content of the cerebrospinal fluid at intervals of from one to one hundred and twenty hours after the intravenous administration of 3 Gm. of tryparsamide. A similar investigation was previously made by Myers and myself after the intravenous administration of 0.2 Gm.

of silver arsphenamine. We found that after this dosage of silver arsphenamine, which represented one fifteenth the amount of tryparsamide, arsenic was present in the cerebrospinal fluid in amounts averaging from three to eight times that present after the administration of tryparsamide. At present Dr. Myers, Dr. Haskins and I are investigating the arsenic in the cerebrospinal fluid after the use of tryparsamide alone and after treatment with tryparsamide combined with hyperthermia. This may furnish some information regarding the effect of hyperthermia on vascular permeability.

PHILADELPHIA PSYCHIATRIC SOCIETY

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JOSEPH C. YASKIN, M.D., *President, in the Chair*

WHAT KILLS CERTAIN PSYCHOPATHIC PATIENTS? REPORT OF TWO ILLUSTRATIVE CASES. DR. ELBERT A. MACMILLAN.

At the Philadelphia General Hospital a rather impressive group of psychotic patients have been admitted who were apparently in excellent physical health in whom after a few days fever, tachycardia and evidences of failing circulation developed and death occurred without demonstrable clinical cause. I shall discuss 2 characteristic cases from this group.

In 1934 Davidson (*Am. J. Psychiat.* **91**:41, 1934) reported 22 cases of a similar type. He said: "There is no particular condition demonstrable that would account for the exitus. Because of an elevated temperature and some changes in breathing we think at times of pneumonia, at other times, because of circulatory difficulties, we are inclined to consider a heart condition; but in the cases we are considering such assumptions are unsupported by physical findings." Davidson reported 4 cases in which autopsy was performed. The pathologic changes consisted of "uniform visceral congestion to the point of hemorrhagic states." There was cerebral edema of considerable degree. The heart was pronounced normal in all 4 cases. There was no mention of such degenerative changes in the central nervous system as I have noted. Otherwise, both clinically and pathologically, my cases are parallel to his.

Derby (*Psychiat. Quart.* **7**:436, 1933) in reviewing the deaths of 386 patients with manic-depressive psychoses during five years at the Brooklyn State Hospital discovered that in 8 per cent there was not sufficient evidence anatomically to account for death on an infectious basis. He stated that "toxemia and terminal acute cardiac dilation" were responsible for death. Bamford (*J. Ment. Sc.* **75**: 120, 1929) expressed the belief that dementia praecox should be called a physical disease, basing his opinion on the observation of well marked fibrosis of all the solid viscera, associated with cardiovascular infantilism. He spoke of an acute form of the disease, in which there is marked wasting followed by death.

CASE 1.—J. T., a Filipino, aged 35, was admitted to the Philadelphia General Hospital to the service of Dr. O. S. English on July 26, 1935. His wife said that the patient had been mentally clear and physically well until the morning of admission, when his daughter was committed to the House of Detention by the court; following this he became agitated, shouted, cursed and ran wildly about the house. He attempted to attack his wife and children and was subdued by the police with difficulty. Examination revealed the patient to be in a state of extreme agitation and confusion; he was throwing himself violently about the bed. Physical examination gave entirely negative results. The blood pressure was 142 systolic and 90 diastolic. Laboratory studies revealed normal urine and negative Wassermann reactions with blood and spinal fluid. The patient remained in a state of agitation

and confusion, without apparent physical abnormality. On July 29 the temperature and pulse rate began to rise; the patient grew gradually weaker and died on July 30.

A complete autopsy was performed by Dr. J. W. Welty. Macroscopic examination showed acute passive congestion in the spleen, kidneys and liver. The heart showed a rather marked acute myocardial degeneration. Microscopic examination confirmed the gross observations. The brain, examined by Dr. Regina Riggs, was acutely congested and edematous. Microscopically, there was intense congestion with perivascular edema in the neighborhood of the small cortical vessels. The ganglion cells of the basal nuclei were swollen and shadow-like, with total loss of Nissl substance. In the medulla there was intense stasis with extensive perivascular demyelinization around the floor of the fourth ventricle, especially in relation to the dorsal motor nuclei of the vagus.

Case 2.—F. R., a white woman, aged 24, was admitted to the Philadelphia General Hospital to the service of Dr. F. H. Leavitt on July 15, 1935. She had always been seclusive, had spent little time with other persons and for the past six weeks had been sitting around staring vacantly into space. It was stated that she had recently taken a violent dislike to her mother, with whom she had ordinarily been congenial. On July 14 she went to church and in the middle of mass left the pew and crawled to the altar on her knees. On the following day she began to talk incoherently and did not go to work. On physical examination the patient seemed well nourished but excited. There were no appreciable physical abnormalities. The blood pressure was 128 systolic and 76 diastolic. Laboratory studies revealed normal urine, a blood sugar content of 92 mg. per hundred cubic centimeters, a blood urea content of 16 mg. and a negative Wassermann reaction of the blood and of the spinal fluid. On the fourth day after admission the temperature and pulse rate began to rise without demonstrable physical cause. The patient grew gradually weaker and died on July 23.

Complete autopsy was performed by Dr. R. W. Mathews. Macroscopic examination of the viscera showed uniform acute passive congestion of the lungs, spleen, kidneys, ovaries and liver. There was acute myocardial degeneration. Microscopic examination of the viscera confirmed these observations and revealed nothing new. The brain was examined by Dr. Regina Riggs. Grossly, there were intense cerebral congestion and edema. Microscopically, there was widespread cellular degeneration, apparently secondary to increased permeability of the capillary bed. The vegetative nuclei of the tuber showed cells devoid of Nissl substance, with a swollen, irregular body.

Orientation of Time in Psychotic, Neurotic and Delinquent Persons. Dr. Samuel Leopold.

Time is a fundamental concept in an understanding of the world. For the clinician, time must be regarded, subjectively, as well as objectively, as a part of the life of the patient. It is with this aspect of the subject of time and its orientation in various personalities, the neurotic, the psychotic and the delinquent, that I shall deal. There is an objective time and a subjective time; both have been studied. In children, in the people of primitive races and in higher apes, objective and subjective time should present a similar picture. This should express itself as simple duration or the present. There may be an immediate past and an immediate future, but events will have equal significance and will not stand out prominently as past, present and future.

It has been assumed first that subjective feeling for time can be divided into the person's feeling regarding past, present and future. A person with dementia praecox, for example, shows a subjective feeling for time of purely primitive duration, having no regard for past, present or future. A person with manic-depressive psychosis in the depressed stage projects entirely into the past; in the manic stage the subjective feeling is in the future. In the person with senile psychosis the subjective feeling of time is entirely in the past. The patient with an expansive type of dementia paralytica projects into the future, showing little regard for past or present. In the anxiety neurosis and the compulsion neurosis

there is also a projection into the future. The patient with conversion hysteria projects into the past. Different from all these is the picture of the habitual delinquent, who lives entirely in the present.

Studies were made on a group of patients with dementia praecox, manic-depressive psychosis, dementia paralytica, senile psychoses and tumor of the brain and of delinquent persons for the purpose of discovering whether marked differences were shown in their subjective feeling for time. Is it possible to differentiate these various groups by their relative attitudes toward the orientation of time, subjectively? The technic used was: The objective feeling for time was first obtained by determining the awareness of the patient to clock time, dates, etc. The subjective feeling for time was studied first regarding the passage of time, whether fast or slow, and in what situations such feeling occurs; for example, passage of time in school, with friends and at work. Here the memory of the passage of time in the past was obtained. The patient was told about the division of time into past, present and future and then is asked whether his thoughts were confined to any one of the divisions more than the others. The cases of dementia praecox were chiefly of the hebephrenic forms, and a few were of the paranoid type. The reactions of persons with the hebephrenic form showed the subjective feeling of time as simple duration. As expressed by many of the patients, time was flat and all the same; there seemed to be no past, present or future. Objective time may or may not be disturbed. In the manic-depressive group, subjective orientation was in the future in the manic phase and in the past in the depressed phase. As far as events were concerned, the objective sense of time was good. With regard to duration it was usually good. Five cases each of senile psychoses and dementia paralytica were studied. The senile psychoses correspond with the theoretical picture conceived; thoughts are projected into the past. In the persons with dementia paralytica there was disturbance in both objective and subjective senses of time. In the psychoneurotic group, depending on type, the following disturbances in the subjective sense were noted: In the persons with compulsion neurosis and anxiety hysteria the subjective feeling for time was chiefly in the future, irrespective of occupation or interest; this is similar to the reaction of the psychotic patients, but in a minor degree. In the patients with conversion hysteria it was mainly in the past. As yet, too few cases have been observed to determine how constant this feature is. In the delinquent patients, those in whom behavior difficulties are the outstanding feature, the subjective feeling for time was found predominantly in the present, similar to that in apes, in children and in the people of primitive races. Findings in a group of delinquent persons from the municipal court were corroborated by similar observations on inmates of the Eastern State Penitentiary. From the study of a few persons there it was found that the subjective sense of time when the person was out in the world was in the present.

While it is impossible to draw conclusions from such a limited number of subjects, it is hoped that this "time test" may prove to be a future aid in diagnosis in the various groups cited.

DISCUSSION

Dr. Earl D. Bond: My own sense of the reality of time, I must say, has been rather shocked because it has been four or five years since I went over the material with Dr. Leopold when he formulated his ideas. I have thought of it since only in respect to psychopathic persons. I think that I told Dr. Leopold of a psychopathic patient I knew well. He was an attractive man who obtained a job and worked excellently for five days, until Friday night. On Saturady at noon he was to receive $50 for his week's work, but on Friday night he was given $10 to take on some errand for his firm. He ran off with the $10 because at that moment the $10 was worth everything. He lived in the present, as Dr. Leopold says, and the future, tomorrow, was nothing to him.

Dr. Robert S. Bookhammer: When Dr. Leopold came to the hospital and proposed this unusual piece of work I was extremely interested in it and glad to aid him in selecting the patients and in going over the data obtained with him. In the main, it can be said that Dr. Leopold's observations are about what one

would expect on giving this matter thought. It is probable that the disinterestedness of patients with dementia praecox in subjective feeling for time accounts for the actual objective disorientation which they so frequently show.

I think than one would expect a depressed patient, particularly in the involutional epoch, who is condemning himself for past acts and sins to have a feeling that there is no future; consequently he would not look much into the future. The patients with schizophrenia of the paranoid type do not seem to have as much alteration from normal in their subjective feeling for time as persons with the other types of schizophrenia. This is probably because the delusional content of the mind is usually centered about some persecution or other, and such patients do have some interest in their future welfare and more awareness of what is going on about them.

The entire subject of emotional feeling concerning the passage of time needs further elaboration. I know of no more useful way of eliciting this information than by employing Dr. Leopold's formula. The replies to these questions would give some aid in differentiating between psychoneurosis and schizophrenia, especially. I do not think that Dr. Leopold hopes to simplify psychiatric diagnosis to the degree that one might ask three simple questions and arrive at a diagnosis of psychoneurosis, manic-depressive psychosis or schizophrenia.

Dr. John Chornyak: I have not had any personal experience in this subject, but I cite a few of Pavlov's observations about time in his work on conditioned reflexes. These observations are in harmony with those of Dr. Leopold.

Time was made a conditioned stimulus by Pavlov. If the time was thirty minutes, then there was a secretion of saliva after twenty-nine or exactly thirty minutes.

The orientation of the delinquent patient in the present found by Dr. Leopold is probably based on Pavlov's work on the trace reflex. In some dogs (and some children, as shown by Krasnogorski) it is difficult to form a trace reflex, i.e., a reflex to the trace of a preceding stimulus. The delinquent behavior characterized by inability to integrate acts in the present with the past may be considered to be due to the failure to form a trace reflex, since the stimulus has not radiated throughout the cortex and therefore has not been able to become integrated.

The depressed patient is characterized by a predominance of inhibition more or less uniformly throughout the cortex. Stimuli coming in therefore become inhibitory. There is thus no positive or a greatly decreased positive response, and hence the patient reflects this physiologic process by living in the past.

In the manic patient there is a marked decrease in inhibition. He responds positively to stimuli. Positive responses are reflected in consciousness and therefore the intense consciousness of the present is projected into the future.

The orientation of the schizophrenic patient to time was found by Dr. Leopold to be "flat." The patient "lives neither in the present, past or future." This can be considered as due to the presence in the cortex of relatively fixed islands of excitation and inhibition, the reflection of which into consciousness results in the disintegration of the total pattern of behavior or personality. Stimuli from the present cannot, therefore, become integrated because of this dissociation. This being the case, there is no reflection of time in consciousness, and it ceases to have any meaning to the schizophrenic patient.

It is remarkable and interesting to find that Dr. Leopold's observations can be so well explained by the conditioned reflexology worked out by Pavlov.

Dr. Joseph C. Yaskin: I wish to ask Dr. Leopold if the whole question of orientation of time in relation to the past, present and future is closely connected with other psychisms. Can one think of present, past or future apart from affective reactions, or can one dissociate the idea of time from projections and association of ideas for that reason? The elated patient would, needless to say, plan and think of the future; the depressed patient would think more and more on the errors of the past, and the anxious patient would think of the immediate danger. It seems to me that in this division of time the whole question of orientation of

time is so closely bound up with various intellectual and emotional processes that it will be of value only when correlated with other psychic processes.

Dr. Samuel Leopold: I am unable to to answer Dr. Yaskin's question offhand. It may be stated that all perceptions come through the senses; whether they are feelings or are organized into ideas the external stimulus is the same, and for the sake of convenience one gives them a name. Closely related to this is the question of how early children develop a sense of time. Studies were made by two Frenchmen, and their attempts to interpret the sense of time in children through the use of a vocabulary was interesting. The conclusions were that from the age of 1 year and 9 months to 2 years the now, the present, could be found, and also a little bit of the idea of past and future.

One does not expect that this study of the reaction to time is sufficient in itself to differentiate the various groups; it is merely an aid to supplement other investigations.

Further Studies of Therapy with Hematoporphyrin Hydrochloride for the Affective Psychoses. Dr. Edward A. Strecker, Dr. Harold D. Palmer, and Dr. Francis J. Braceland.

Since March 1933 we have been observing the effect of the administration of synthetic hematoporphyrin hydrochloride on psychotic patients. In a report published in May 1934 we stated that 37 patients had received intensive treatment both oral and intramuscular, with the results that of 31 with affective reactions 9 showed marked sustained improvement, 7 showed moderate improvement, 8 made general physical gains and 7 showed no change. Six schizophrenic patients were given the same course of treatment, but of this number only 1 showed general physical and mental improvement and was able to return to his occupation.

Since the publication of these results we have observed the clinical results of oral administration of hematoporphyrin hydrochloride in a larger group of patients and from several different angles. Twelve institutional patients with psychoses of long standing were observed with regard to the metabolic responses to the chemical, while a larger number of noninstitutional patients were observed from the standpoint of clinical improvement only. In the 12 no significant changes were noted in the basal metabolic rate, the red and white cell counts and the hemoglobin and the calcium content of the blood. A total, from both groups, of 61 patients was treated, 55 of whom suffered from affective disorders. Of this number, 20, or 36.4 per cent, showed marked sustained clinical improvement; 10, or 18.2 per cent, moderate clinical improvement; 10, or 18.2 per cent, physical improvement but no material benefit mentally, and 15, or 27.2 per cent, no change.

The mechanism of improvement is not clearly understood, although it is thought that the photodynamic actions of the substance promote the oxygen uptake of the cerebral tissue. The photosensitizing power of the synthetic preparation has been established, and most patients show increased sensitization to the sun and to artificial ultraviolet rays.

DISCUSSION

Dr. Robert A. Matthews: The 8 patients I had occasion to follow, mentioned by Dr. Palmer, were treated at the Philadelphia Hospital for Mental Diseases during the past year. These patients were not chosen with the idea of picking out the most likely type to improve under this treatment. The patient who showed the most remarkable improvement was a woman, aged 52, with involutional melancholia, but with some definite reactive elements. She seemed to improve remarkably at first. She gained weight, slept better and rapidly became less depressed and less agitated. She left the hospital and for a time did not receive additional hematoporphyrin hydrochloride. She was then referred to the Institute of the Pennsylvania Hospital. Unfortunately, the depression returned, and when the patient was last heard from she had not responded to a second course of hematoporphyrin hydrochloride.

A second patient, a man with involutional psychosis of the depressive type, objected strenuously to the intramuscular injections because he said they were

making him worse. He showed a marked response and after one course of treatment left the hospital and has remained well. Certainly the psychotherapeutic element was unimportant in this case.

A patient with an involutional psychosis of seven years' standing was used as a control. He at first objected strenuously to treatment and had to be led to the physical therapy department; later he would go for ultraviolet irradiation without objecting and became more alert than he had been in five years, but on cessation of the treatment he immediately reverted to his previous state.

Still another case was that of a woman in which the diagnosis lay between a catatonic form of dementia praecox and a manic-depressive psychosis of the depressive type. She improved rapidly at first and was able to leave the hospital after one course of treatment, but when last seen she was not well and, I think, was beginning to show some more schizoid symptoms.

Two other patients did not show much improvement during the course of treatment but recovered soon after treatment was terminated. Two patients showed no noteworthy response to administration of the drug.

I have used hematoporphyrin hydrochloride in 3 cases of psychoneurosis with depressive elements. Two patients, I thought, showed definite response, but I do not think that it is possible to evaluate the result of the treatment properly because of other elements present.

It seems to me that there is a place for this drug in the treatment of various psychoses because it provides an urge or push. In patients convalescing from severe physical illnesses it would appear that a drug of this sort might just turn the tide toward a more rapid improvement. I think that it will bear further investigation in both the psychiatric and the general medical field.

DR. W. COLE DAVIS: From the foregoing reports I understand that most responses were observed in patients with psychosis of the depressive type who had lost considerable weight, as the drug had a particularly good effect on metabolism. I wish to ask about the use of the drug in the series of epileptic patients. Was it given by mouth and how much was given?

I wish also to mention a case in which the drug was given. It was noted that when the patient went out in the sun she was burned. The nurse who had been in charge of the patient for two years and who was not familiar with the drug remarked on coming in that she had never known the patient to burn like that and that she had not been in the sun longer than usual.

DR. SAMUEL LEOPOLD: I have used hematoporphyrin hydrochloride in 7 or 8 cases of psychosis and particularly in cases of psychoneurotic depressions. My conclusions were about the same as those of Dr. Matthews. Although one cannot evaluate the effect of the drug, I think that it is worth using in this group. I wish to call attention to a man who was subject to recurring attacks of depression every year. He really belonged in the psychoneurotic group. The attacks of depression were sufficiently severe to make it necessary for him to be hospitalized. During the last attack hematoporphyrin hydrochloride was used; to my surprise the patient did not have to be hospitalized and had just sufficient push to keep going at his job instead of retiring from it completely. He made a good recovery. My conclusion would be that its use in the psychoneurotic group must be carefully evaluated to determine just what part the drug plays.

DR. HAROLD D. PALMER: In answer to Dr. Davis' question regarding dosage, we have been using 10 drops three times daily before meals, gradually increasing the dose until 30 drops is given three times daily before meals. French writers on the subject, particularly André, gave hematoporphyrin hydrochloride in doses of 100 drops three times daily, elevating or decreasing the dose when the patient showed either slight benefits or overstimulation and excessive photosensitization. I am particularly pleased to have Dr. Leopold's remarks about his successes with this drug in the treatment for mild depression of the so-called "psychoneurotic" type. I think that this somewhat questionable classification of "psychoneurotic depression" is a convenient term to use in describing mild manic-depressive

depression in which somatic symptoms and neurotic complaints predominate. The patients whose cases I have cited tonight whose records I utilized in making up statistics as to improvement, recovery, etc., belong in the institutionalized group with severe depressions and involutional melancholias. Those with mild types of depression, whom as a whole one might call an extramural or ambulatory group, were, of course, not so suitable for close study, and I did not think that control of these patients was sufficiently careful to justify a report of the specific factors bringing about improvement.

NECESSITY OF APPLYING PSYCHOTHERAPY EXCLUSIVELY. DR. O. SPURGEON ENGLISH.

Psychotherapy is unique among forms of therapy, as nothing comes in contact with or enters the human body. Used alone, it precludes physical contact and is designed to affect reason and emotion primarily and the body secondarily. With some conditions there comes a time when it is the only therapy of value. To use it successfully it is necessary that the physician be convinced of the psychogenic etiology of symptoms and that he be equipped with a knowledge of psychopathology to go with the patient below a surface exchange of ideas and the handing out of a few platitudes. The patient should be prepared for psychotherapy by having sketched for him some interrelationships of mind and body and by being asked to give his cooperation in the psychotherapeutic work. A schedule for the necessary interviews should be made and adhered to as definitely as possible.

With rare exceptions no other therapy should be given at the same time as psychotherapy. If additional therapy is necessary, it should preferably be given by another physician. The potency of psychotherapy by any physician is vitiated if other medical measures are combined with it.

The public is not yet ready to let itself be looked on as having symptoms of emotional origin only. This still has the implication of being "mental illness" or of "having nothing wrong." Physical measures in treatment are more readily appreciated by the senses and have enjoyed prestige for centuries. They give tactile gratification as well as have a suggestive effect.

For these reasons and others they will be preferred by the patient, and hence if psychotherapy is necessary it must be used alone and with the patient's full participation in it. Its importance should be substantiated by the withdrawal of other therapeutic agents. Without the exclusion of other therapies the necessary cooperation for the best and most lasting psychotherapeutic results will not be forthcoming.

DISCUSSION

DR. EARL D. BOND: I listened critically to this interesting paper but can find little to object to because Dr. English has guarded his statements well. Of course, proper physical and laboratory examinations are the preliminary to any diagnosis. Most patients will try to center the attention of the physician on the organic in order to avoid disagreeable mental facts. It is worth considering how two physicians can handle one patient. This has been tried with children in the Franklin School. A psychiatrist has worked steadily with the child on its emotional problems, and when a physical ailment arises the child has been referred to a pediatrician.

DR. LAUREN H. SMITH: I believe that few can disagree with the basic principles outlined in Dr. English's paper. However, I wish to refer to the practical use of psychotherapy under present clinical conditions. It is impossible at times for psychotherapy to be used and at the same time to exclude all other forms of therapy. In the first place, there are cases in which other treatments are needed for secondary conditions, and with such patients there are definite reasons for psychotherapeutic treatment at the same time. Second there is the point about the efficacy of psychotherapy and the principle on which one believes it to be based. By this I mean that if one can achieve the results one believes one does by the use of psychotherapy, can one not by the same psychotherapeutic technic

straighten out any difficulty the patients may have in regard to an understanding of the true psychogenic origin of the illness? In other words, if psychotherapy is so effectual in psychogenic situations, I can see no reason why it could not be equally effectual in straightening out the patient's difficulties in regard to the possible question as to the physical origin of the symptoms or difficulties. I hope that it will be found through increase in knowledge in using psychotherapy more efficiently that one can make patients distinguish more clearly that which is somatic from that which is psychic, at least to the limits of human consciousness as to such differentiation.

Dr. O. Spurgeon English: I am grateful for this discussion of this problem. In reply to Dr. Yaskin in regard to the occasional necessity of drug therapy and how it shall be managed, with one doing a great deal of psychotherapy this would, as I see it, present no practical problem if both parties realized that it was a temporary arrangement. But, as I stated in my paper, the necessity of this is actually infrequent, and this should be stressed in order to prevent a too frequent use of drugs by those inexperienced and unacquainted with the potency of psychotherapy alone. Once it is seen as the only therapy available, it will be utilized by the patient to much greater advantage.

Dr. Smith spoke of the day coming when one can discuss with the patient with equal facility what is somatic and what is psychic. I believe that such a day is coming, but I also believe that it is going to come more quickly if as many as possible adopt psychotherapy exclusively when it is used at all and thereby more clearly demonstrate its usefulness.

Book Reviews

Current Trends in the Study of Aphasia, Apraxia and Agnosia. Price, 4 roubles. Pp. 167. Moscow, U. S. S. R.: State Publishing Company, 1934.

This volume presents a series of papers published by the members of the Clinical Division of the Neurological Institute of Moscow. The new ideas with which the papers deal are largely those of Kurt Goldstein and Paul Schilder; these are illustrated by reports of cases. Stolbun reports two interesting cases of "constructive apraxia." This condition followed a cerebral insult in one case and a gunshot wound in the other. In both cases, in spite of the fact that intellectual functions returned rapidly after the injury, there remained a residual inability to draw, draft or copy or to make most simple designs. The author points out that this is due to disturbances in the sense of spatial orientation, which are the cause of apraxia. Edinova and Futter point out that, following a cerebral injury or a vascular change, when the patient reacquires speech and thinking functions there is a complete change in the whole person rather than a mere return of the old functions. This, of course, is one of the fundamental ideas of Kurt Goldstein.

Zegarnik and Birnbaum report studies on the meaning of words and proverbs in schizophrenia. They point out that a schizophrenic patient cannot deal with the symbolic meaning of words and that there is a marked tendency toward literal interpretation, all of which is a result of the fundamental disturbance of thinking in schizophrenia. Their conclusions thus confirm the ideas of Vigotsky ("Thought in Schizophrenia," ARCHIVES OF NEUROLOGY AND PSYCHIATRY **31**:1063 [May] 1934), who pointed out that in schizophrenia there is a loss in the function of concept formation, with regression to primitive forms of thinking.

The volume is edited somewhat hastily. The paper is poor; some of the references are inaccurate, and the illustrations are unsatisfactory. This shows that technical conditions involved in the publication of scientific books are still unsatisfactory in Russia.

Handbuch der Neurologie. Edited by O. Bumke and O. Foerster. **Volume X. Special Neurology. Part II: Diseases of the Vertebrae, Skull, Sinuses and Meninges.** Price, 92 marks. Pp. 465, with 105 illustrations. Berlin: Julius Springer, 1936.

The first article in this volume, by Max Lange, is on diseases of the vertebrae. It is comprehensive, well presented and clearly illustrated. It contains a good account of the various forms of spondylitis. There is an adequate discussion of tumors of the vertebrae and spinal meninges by Nils Antoni. Werner Schulze contributes an excellent discussion of diseases of the skull. There is a good article on the intracranial complications of sinus disease by Oskar Hirsch and a clear presentation of otogenous intracranial complications by Hans Brunner. Pachymeningitis and leptomeningitis are well reviewed by H. Pette, who includes not only the most commonly known forms but many rare forms of meningitis as well. The volume ends with a brief discussion of subarachnoid hemorrhage by L. Ehrenberg.

All the articles are well written and are, on the whole, adequately illustrated, and the volume makes accessible to neurologists material which it is not possible to find elsewhere in a single volume. The reviewer refers specifically to the studies of the vertebrae, sinuses and skull. The book can be recommended highly.